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ABSTRACT

As the oceans rose due to melting glaciers, the Chesapeake Bay became a crowned valley. The Bay is a biologically rich system in which the success of each species depends on the quality of water in the parts of the Bay used during its life history. With the increase in human population, technological developments associated with industrial activities and power production, wastes, dams, fishing activity, silt, and wetlands are making a significant impact on the Bay. This curriculum unit is designed to examine the management of this threatened and complex environmental system. The package consists of five components: (1) an introduction to the historical and ecological significance of the Chesapeake Bay region, including a fact sheet, slide-tape presentation, and a set of land-use maps; (2) a videotape presentation of viewpoints dealing with current and future problems of the sea; (3) a teacher's guide outlining a conference simulation during which students as conference participants are involved; (4) a data bank reference source based on a U.S. Army Corps of Engineers document for use by students in identifying issues and substantiating policy statements; and (5) applications to local concerns, where students can make recommendations for issues in their own area. "Student Materials" offers a fact sheet and materials for the simulated conference. The appendices provide information and procedures for teachers, including audiovisual scripts and a cross reference to the Chesapeake Bay Data Bank. (RI)

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DECISION MAKING: THE CHESAPEAKE BAY

An Interdisciplinary Environmental Education Curriculum Unit

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THE
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DECISION MAKING/ THE CHESAPEAKE BAY

Foreword to the First Edition with Acknowledgements

The Chesapeake Bay is a drowned valley of the Susquehanna River, created about 11,000 years ago as the oceans rose because of melting glaciers. This is the largest estuary in the United States: 4,400 square miles, 200 miles long and on the average 15 miles wide, with over 7,000 miles of shoreline.

The Bay, as a biological system, is exceptionally rich. Plants are the basis of all food production, with the great marshlands of Maryland and Virginia important as food factories and storage depots in this system. Plant-feeders include microscopic copepods and other crustacea, oysters, clams, and larvae of many species. Some of the plant-feeders are eaten by sea nettles, young fish, and in turn by large carniverous striped bass, bluefish, and sharks. Eventually crabs and other scavengers complete the cycle of the food web, which leads to death, decay, and recycling.

The success of each species depends on the quality of water in the parts of the Bay used during its life history. The product is a rich mosaic of patterns of migration, reproduction, feeding, and growth. These patterns have evolved over thousands of years in the Bay to produce a highly dynamic and rich population of animals and plants which has greatly benefited humanity.

Today, when the human population surrounding the Bay doubles every 30–40 years and technological developments associated with industrial activities, power production, and other forces steadily increase, the following effects are now large enough to be measurable and to raise serious concern:

Domestic wastes are in some cases still releasing bacterial loads which threaten health and nutrients which encourage the growth of algae and reduce the quality of the water.

Diversion of fresh water from rivers draining into the Bay now slightly increases salinity over a large area during some seasons.

Dams prevent fish migration to some spawning grounds, and change the natural patterns of water flow in the Bay.

Industrial wastes have placed large quantities of chemicals in the sediment of city harbors, and there is continual leakage (with occasional major spills) of chemicals. Portions of the tributaries are warmed by waste heat from power plant condenser cooling.

Agricultural wastes are over-enriching some tributary waters, and runoff is carrying pesticides into the estuary.

Wetlands are being eliminated by filling or dredging.

Silt continues to invade the Bay from agricultural land runoff and construction projects (as well as from accelerated shore erosion produced by the wakes of boats and large ships).

Fishing removes from the biological populations of the Bay about five hundred million pounds of fish and shellfish per year for commercial use, and a huge, unmeasured sports catch. The effects of this large, continuous removal are not fully understood.

Dredging and spoil disposal to create and maintain deeper channels are known to reduce the living organisms of the Bay.

Thus, there is now scientifically acceptable evidence that humanity is having significant effects on the Bay. Most of these changes *damage* the ecosystem, *lessen* the efficiency of the biology of the Bay, and *reduce* some of the uses to which people can put this great estuary.

It is the responsibility of all Bay citizens to become aware of problems associated with maintaining the Bay. It is also legitimate to expect them to comprehend and/or have input into the decision-making process by which the future health of the Bay is determined.

Enhancing the probability of fulfilling these citizenship goals rests primarily on the schools and other educational organizations. A conference was held in November 1977 at the University of Maryland's Science Teaching Center to consider this matter. At the conference, educational leaders from the University of Maryland, from Maryland urban and suburban county school systems associated with the Bay (e.g., Charles County, Prince George's County, Baltimore County, Baltimore City, Montgomery County, and Anne Arundel County), and from the Maryland State Department of Education determined that because of the complexity of the biological, political, social, and economic factors involved in the decision-making process, no individual teacher, school, or even school system had been able to create a comprehensive program which addresses the major Bay issues.

It was proposed by the conference participants that a project staff be created to produce a multidisciplinary and simulated decision-making experience concerning the management of the Chesapeake Bay for senior high school students and others. This action led to the synthesis of a curriculum-development proposal and subsequent funding by the Office of Environmental Education, United States Office of Education, to produce a multimedia package providing a wide range of information and opinions concerning the delicate balance necessary for the well-being of the Chesapeake Bay ecosystem.

Based on the acquisition of social, economic, and scientific knowledge, it was proposed that students would become actively involved in experiences to:

1. identify the major Bay issues;
2. ascertain and assess the feasibility of alternative public policies to deal with the issues; and
3. apply their new understanding to the identification and solution of local environmental issues.

The Chesapeake Bay Environmental Education Project began operation during September 1978. The needed support and direction given the project by the Education Advisory Committee is gratefully acknowledged.

My sincere gratitude is extended to the project staff for its tireless effort in a job well done. My personal thanks are given to Bob Hamlin, Chester Hall, Ann Alleman, Charlene Rothkopf, Diane Tessier, and Jack Wheatley for their devotion to the initial curriculum development and numerous revisions, all of which necessitated an effort far beyond the call of duty.

The graphic design of this project (exclusive of the Data Bank) was very ably coordinated by Jim Donnelly, assisted by Henry Schoebel. Mr. Donnelly, who receives our special thanks, also prepared the artwork for both land-use maps, which are integral components of this curriculum unit. The contributions of Douglas McRoy and Paul Malec in handling the technical aspects of producing the videotape and the slide/tape presentation are sincerely appreciated.

A thank-you also goes to Dr. Sue Clabaugh, Director of the Educational Technology Center, and to her secretary, Lois Smith, for facilitating our use of the graphic and media studios and services.

The laudable effort given to the project by the validation teachers was sincerely appreciated by all the staff. Their assessment of the trial materials led to a number of revisions and additions which strengthen the students' learning experience and enhance the teacher's effectiveness.

Our appreciation is extended to the local, state, and federal agencies, and the representatives from the public sector who shared their expertise. In particular, we acknowledge Scott Brumburgh of the Coastal Resources Division of the Maryland Department of Natural Resources for his role in identifying critical Bay issues, and Noel Beegle and all the staff of the Baltimore Office, U.S. Army Corps of Engineers for permission to adapt materials from *Chesapeake Bay: Future Conditions Report* in the preparation of the two land-use maps, and to reprint portions in the *Chesapeake Bay Data Bank*.

Also, we thank the participants in the videotape production *A Question of Balance* for sharing their insights into the problems associated with the management of an ecologically sound Chesapeake Bay.

With deepest appreciation, I recognize the work of the secretarial staff. The constant revisions and deadlines were handled in excellent fashion by Eileen Banner, Cathie Galeano, and Randi Strange.

EMMETT L. WRIGHT, PH.D.
Project Director

Foreword to the Second Edition

During the five years since the release of the first edition of *Decision Making/The Chesapeake Bay,* there have been a few victories in restoring the Bay and its resources. Unfortunately, the losses far outweigh the gains. The steady deterioration of water quality indicators is reflected in the precipitous decline of the striped bass, shad, and oyster harvests. In 1984 the governor and the Maryland General Assembly demonstrated their concern by enacting 34 laws that are designed to reverse the deterioration of the Bay.

The *Environmental Education Initiative* is designed "to teach future generations of Marylanders about the complexity and value of the Chesapeake Bay." One element of the initiative focuses on "the ways in which a democratic process solves complex questions that face decision makers." The *Decision Making/The Chesapeake Bay* curriculum has been identified as an instructional strategy that provides an in-depth examination of the many different users of the Bay. Within the context of a working knowledge of Bay resources and problems, students learn about estuarine science and public policy making at the same time.

Funds have been provided to improve the curriculum in terms of updating the factual information and revising the strategies for playing the simulation game. Reemphasis has been placed on developing the critical thinking skills of students—our future decision makers. In addition, a series of workshops will be funded around the state for the purpose of systematically disseminating the materials to teachers.

I want to thank the many educators who have taught the curriculum over the past five years for the essential feedback used in revising the curriculum. I particularly appreciate the efforts of the Teacher Advisory Committee in providing many useful insights and for sharing specific modifications that have proven successful in their classrooms. Also, the critiques of the materials by the Technical and Scientific Review Committee have been essential in updating the content.

EMMETT L. WRIGHT
Project Director

PREFACE

The passage of Maryland's Chesapeake Bay Program, a series of seven initiatives aimed at improving our understanding and management of the nation's richest estuary, helped make available the reissue of this curriculum unit, *Decision Making/The Chesapeake Bay*. The Maryland State Department of Education, working through the Conservation Education Council, has joined the University of Maryland Sea Grant College to produce these materials, developed by Dr. Emmett Wright, former head of the University of Maryland Science Teaching Center.

Copies of this booklet may be obtained by writing:

The University of Maryland Sea Grant College
Marine Education Materials
H. J. Patterson Hall
College Park, Maryland 20742

The Maryland Sea Grant College is a joint federal-state program of research, advisory services and education designed to encourage wise use, enhancement and conservation of the state's marine and estuarine resources. The reprinting of these materials is an effort of the Sea Grant Communications Group, Dr. Jack Greer Coordinator.

INTRODUCTION

This curriculum unit, *Decision Making/The Chesapeake Bay,* is multidisciplinary and self-contained, designed to examine the management of a threatened and complex environmental system—the Chesapeake Bay. The package consists of five components:

1. An *introduction* to the historical and ecological significance of the Chesapeake Bay region, including a slide-tape presentation, a fact sheet, and a set of land-use maps.
2. A full-color *videotape presentation* introducing various viewpoints concerning the problems confronting the Bay, both currently and in the future.
3. A Bay Interest Groups (BIG) Conference *simulation* where participants assume roles for the purpose of identifying Bay issues, developing policies, and judging the environmental impact of the policies.
4. A Data Bank *reference source* for student referral to identify issues and to substantiate policy statements concerning the Bay's physical, biological, social, political, and economic environments.
5. *Applications* to local concerns, where students use the skills developed in the BIG simulation to identify and recommend policy for issues in their own area of the Bay or a local watershed.

The instructional time frame can vary from as little as 15 class sessions to an entire semester, depending on the intent and interest of participants. Each of the five components can be used independently of the others and/or incorporated into existing units of instruction.

Unit goals

The major goal of *Decision Making/The Chesapeake Bay* is for students to identify and analyze conflicting interests, issues, and public policies concerning the Chesapeake Bay, and to determine their effects on the people and their environment.

Specifically, each student will achieve the following results:

1. Develop a comprehensive understanding of the biological/physical interactions that occur in the Chesapeake Bay ecosystem, as well as the historical, social, and economic significance of the Bay region.
2. Assume the role of a person associated with the Chesapeake Bay and research the individual's concerns relevant to decision making and the Bay's future.
3. Meet with his/her interest group to identify common concerns and plan strategies for influencing the decision-making process.
4. Negotiate the selection of four (out of 20) identified Bay issues for future consideration.
5. Research and develop policy options for each selected issue.
6. Determine the impact of each policy option on the environment and people of the Bay area.
7. Select alternatives for mitigating the negative environmental impact for a given Bay issue.
8. Prepare a report incorporating policy options, mitigating alternatives, and projected environmental effects for a given Bay issue.
9. Apply skills and knowledge gained from the simulation experience in identifying and developing policy for a local environmental issue.

Users

The *Decision Making/The Chesapeake Bay* curriculum unit can be readily used by both science and social studies teachers. It is recommended for courses such as biology, advanced biology, U.S. government, problems of democracy, contemporary issues, and environmental studies. In addition, citizen groups or any other organization associated with the Chesapeake Bay could readily use the materials for the purpose of enhancing their decision-making skills.

Teacher training

Teacher training is required. Training sessions will last two days and are to be conducted by members of the project staff or individuals trained by the staff. Contact the Project Director to make formal arrangements.

Funding

Funding for the development of the *Decision Making/The Chesapeake Bay* curriculum unit was provided by the Office of Environmental Education, United States Office of Education; and by the Department of Secondary Education, College of Education, The University of Maryland, College Park.

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TEACHER'S GUIDE

DECISION MAKING

THE CHESAPEAKE BAY

OVERVIEW

Decision Making/The Chesapeake Bay, a self-contained environmental curriculum unit, has been designed for secondary students and adults to examine the management of a complex and threatened environmental system—the Chesapeake Bay. The materials have been used successfully with groups from the upper elementary grades (gifted and talented) through middle school, high school, college, and various adult groups. The program has been incorporated into different courses of study including high school biology, social studies, problems of democracy, environmental science, and courses that have a major objective of promoting critical thinking skills. Numerous informal instructional settings throughout the mid-Atlantic region have profitably utilized the unit in field-based programs (e.g., Chesapeake Bay Foundation programs, Maryland State Department of Education Summer Gifted and Talented Programs, gifted and talented programs of the Richmond, Virginia Science Center). In addition, the materials have been wholly or partially adapted for use on Cape Cod, in southern Florida, in Australia, and in England.

The unit components can be used separately or as a total package. It has been shown that a creative educator can easily integrate the various components into an effective program of study.

Goals

The unit has the following five major goals:

1. To promote an understanding of and an appreciation for the Chesapeake Bay ecosystems through the study of issues associated with the Chesapeake Bay and region;

2. To provide basic scientific information essential to understand the complex ecological systems that maintain a healthy Bay;

3. To consider the historical, economic, social, and political variables that influence various viewpoints that impact on Bay uses and management;

4. To explore the decision-making process for developing environmental public policy at local government and state government levels. Students will learn about communication, cooperation, and compromise. They will develop an understanding of the complexities involved in meeting the needs of a diverse community. Through content and process, students will analyze the conflicting interests and environmental issues of the Chesapeake Bay and region;

5. To encourage the analysis and development of public policy for environmental problems in the local community. Students will use this new knowledge to form positive, action-oriented attitudes toward decision making in the local community.

Objectives

In *Decision Making/The Chesapeake Bay*, the students will:

1. Identify and analyze the key economic, political, social, biological, and physical factors and interactions associated with the Chesapeake Bay and region;

2. Describe the competing and conflicting pattern of issues and groups around the environments and the people of the Bay area;

3. Analyze current management policies and schemes, at the federal, state, and local levels, for maintaining a healthy Bay ecosystem;

4. Develop critical thinking skills for solving problems facing the Bay by participating in a problem-solving simulation where each student will:

(a) Assume a given role and research the concerns relevant to the role;

(b) Meet in interest groups to identify shared concerns;

(c) Negotiate and bargain to select Bay environmental issues for further study;

(d) Research, write, and present policy options, one for each environmental issue selected;

(e) Negotiate and bargain to select policy statements for further research;

(f) Determine the impact of each policy option on the environments and the people of the Bay area;

(g) Propose means to lessen any possible negative impact each policy option might have on the evironments and the people of the Bay area;

(h) Prepare a defense of a selected public policy;

(i) Apply critical thinking and problem-solving skills to local environmental problems.

Skills

As a result of *Decision Making/The Chesapeake Bay*, the students will enhance their ability to:

1. Select pertinent information from readings, maps, graphic and audiovisual presentations, and other relevant sources;

2. Organize, analyze, and evaluate data in various forms;

3. Draw conclusions from incomplete data and support the conclusions with additionally researched information;

4. Apply conclusions to assess issues and develop public policy;

5. Analyze relationships between people and issues;

6. Formally present a particular conclusion;

7. Debate conflicting issues;

8. Compromise when conflicting views develop;

9. Reach group decisions;

10. Predict impacts of present conditions and future projections;

11. Participate in the democratic decision-making process.

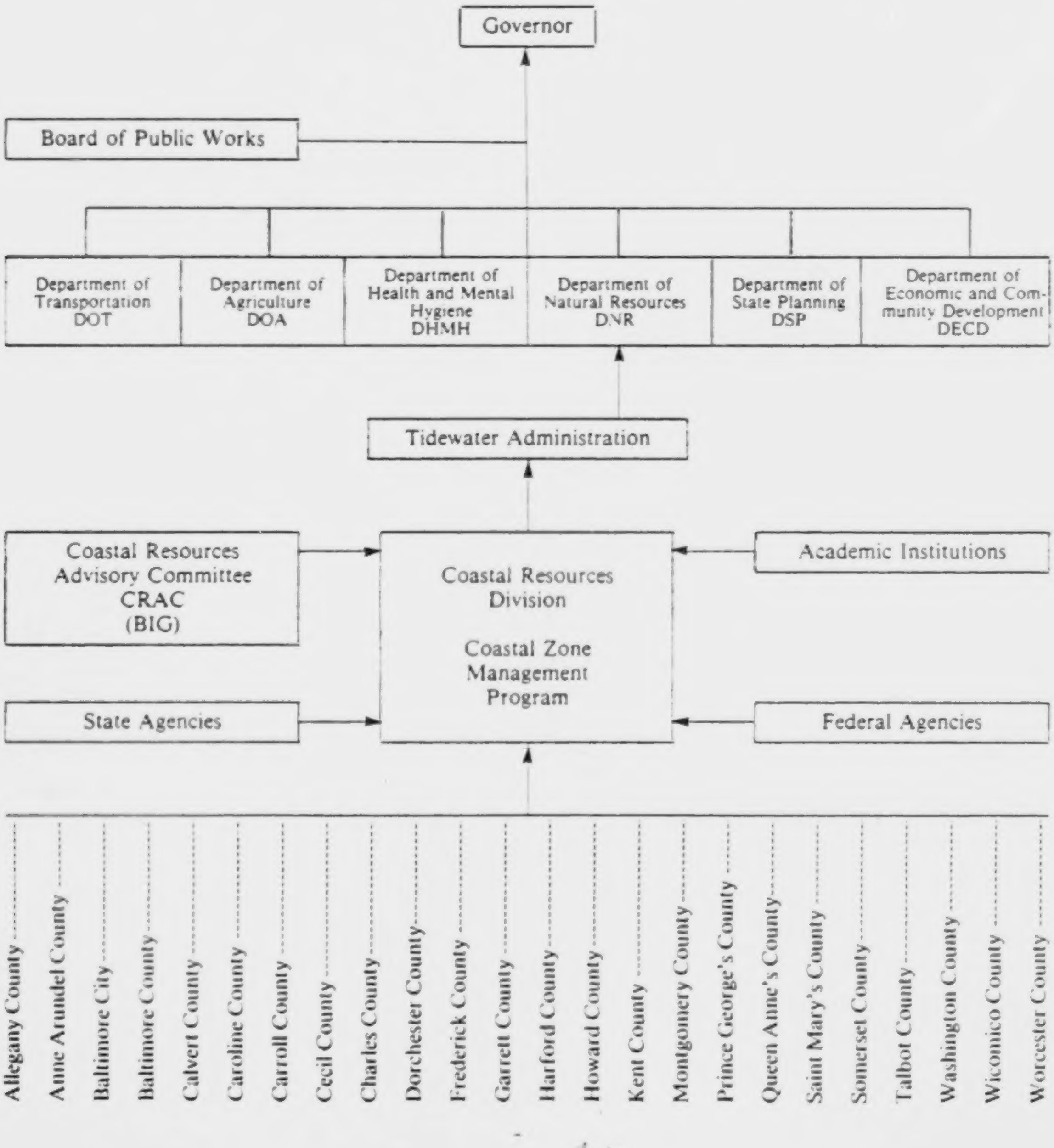
Target Audience

Decision Making/The Chesapeake Bay was originally designed for high school science and social science classrooms including courses in biology, earth science, geography, problems of democracy, contemporary issues, and environmental studies. Science and social science teachers were encouraged to team-teach the unit, whenever possible, sharing their subject-matter expertise and teaching strategies. The unit has also proven to be useful to college ecology and Chesapeake Bay ecosystem courses, training seminars for decision-makers, and citizen groups who want to learn more about managing a complex environmental system. The unit has also been extremely useful in working with upper elementary and middle school classes that emphasize the development of critical thinking skills—in particular, programs for the gifted and talented.

Components

1. *Introduction to the Chesapeake Bay and region.* *(a)* A slide/tape set, "The Chesapeake Bay—What

Figure 1
Organization of Coastal Zone Management Program



It Is to You," presents an overview of the Chesapeake Bay with its environmental setting, products, usefulness, and management needs (see script, Appendix B).

(b) "The Chesapeake Bay Fact Sheet" is available to review important information outlined in the slide/tape set (see Student Materials section).

(c) Two 25" × 38" land-use maps, "Generalized Land-Use Patterns of the Chesapeake Bay Region, 1970" and "Projected Land-Use Patterns of the Chesapeake Bay Region, 2020," depict present and projected future conditions of the Chesapeake Bay Area. Students can refer to these maps when examining Bay issues and developing public policy (available on request).

2. *A color videotape,* "A Question of Balance," presents various views on the problems confronting the Bay. The videotape includes representatives of Bay user interest groups, specifically the wetlands, recreational, environmental, scientific, developmental, industrial, and private interests (see script, Appendix D).

3. *The Bay Interest Groups (BIG) Conference simulation experience.* This simulation is partially based on the Coastal Resources Advisory Committee (CRAC), which advises the Coastal Resources Division of the Tidewater Administration, Maryland Department of Natural Resources, on policy for marine and estuarine matters (see Figure 1 for the organizational scheme). During the simulation experiences, students assume roles to identify Bay issues, develop management policies, and determine the environmental impact of these policies. Student evaluation procedures are recommended.

4. *Student reference sources. The Chesapeake Bay Data Bank,* developed for use with BIG Conference simulation, was adapted from the U.S. Army Corps of Engineers' *Chesapeake Bay Future Conditions Report* and contains information necessary for decision making by students. To assist the teacher, Appendix A cross-references the Data Bank to specific Bay issues and information for specific groups. The Data Bank supplies not only biological and physical data, but also provides information concerning the social, political, and economic factors that affect the Bay. An annotated bibliography of additional sources is included in Appendix C.

5. *Local applications.* Suggested approaches for students to investigate local environmental problems following completion of the BIG Conference simulation are outlined.

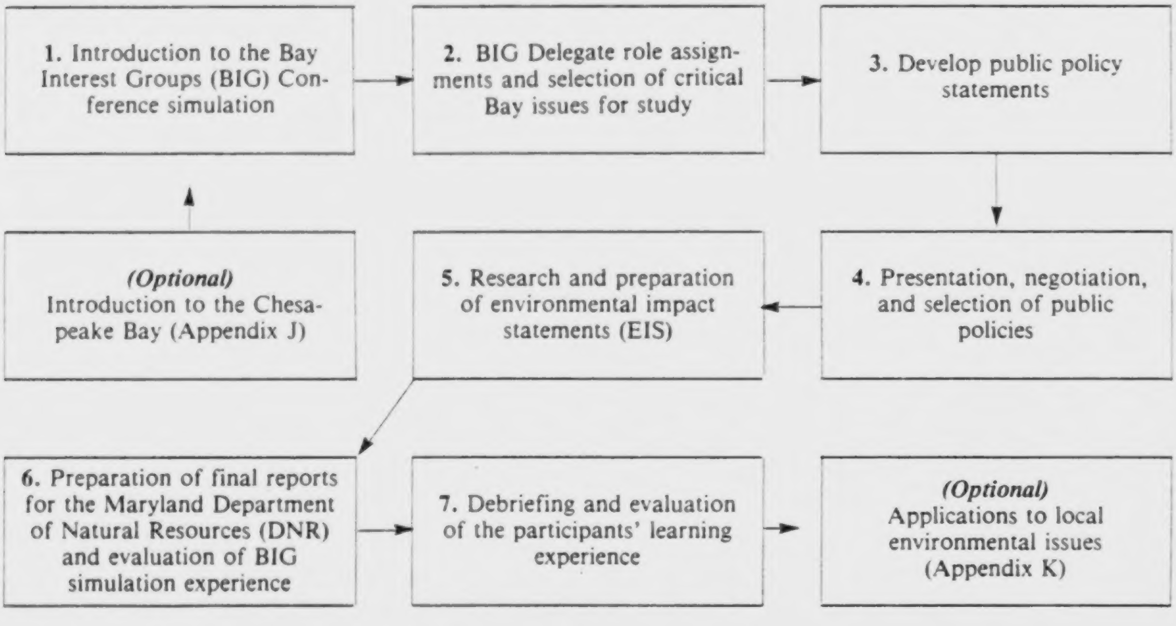
Organization

Decision Making/The Chesapeake Bay is organized into seven activities. The time frame can vary depending on the intent and interest of the students and teacher. The package can be used as a specific unit of study or can be incorporated into existing curricula. Figure 2 outlines the overall process.

- *Activity 1: Introduction to the Bay Interest Groups (BIG) Simulation.* The students receive a letter from the Bay Interest Groups inviting them to a conference that will address the critical problems facing the Chesapeake Bay. As part of the activity, "A Question of Balance," a 26-minute videotape with discussion questions, introduces the complex societal interactions involved in managing the Chesapeake Bay.

An optional activity, *Introduction to the Chesapeake Bay,* offers a variety of suggested lessons that will pro-

Figure 2
Decision Making/The Chesapeake Bay Simulation Activities


1. Introduction to the Bay Interest Groups (BIG) Conference simulation
2. BIG Delegate role assignments and selection of critical Bay issues for study
3. Develop public policy statements
4. Presentation, negotiation, and selection of public policies
5. Research and preparation of environmental impact statements (EIS)
(Optional) Introduction to the Chesapeake Bay (Appendix J)
6. Preparation of final reports for the Maryland Department of Natural Resources (DNR) and evaluation of BIG simulation experience
7. Debriefing and evaluation of the participants' learning experience
(Optional) Applications to local environmental issues (Appendix K)

vide the students with an overview of the Chesapeake Bay. The major goal of this activity is to motivate students to learn more about the Bay and human interaction with it. This activity, found in Appendix J, is particularly useful as a review for a low level group that has previously studied the Chesapeake Bay, or for a group that has little or no background.

- *Activity 2: BIG Delegate Role Assignments and Selection of Critical Bay Issues for Study.* Each student is assigned a unique role with affiliation to one of seven interest groups. Students will examine their assigned roles to determine why their affiliation is reasonable, acknowledging occasional disagreement with other members. They will also decide what they stand for as a group. The list of twenty Bay issues will be distributed to the interest groups so they can begin formulating a position for each issue. Through a negotiating/voting process the interest groups will select Bay issues for in-depth study. The interest groups substantiate their position on the issues through research in the Data Bank and other authoritative sources.

- *Activity 3: Policy Design.* Each interest group designs and evaluates its policies through a procedure provided for developing environmental public policies.

- *Activity 4: Presentation, Negotiation, and Selection of Public Policies.* Each interest group will present its public policy statements along with a brief rationale. The other interest groups are encouraged to question and clarify the presentations.

Following negotiating and bargaining, interest groups vote "for" or "against" policies. At least one policy is approved for each of the issues.

- *Activity 5: Preparation of Environmental Impact Statements (EIS).* Each interest group will research the environmental impact of each public policy. A rationale for each decision will be required.

- *Activity 6: Preparation of Final Reports and Evaluation for the Maryland Department of Natural Resources.* Each interest group prepares a report which requires the synthesis of the previous work for developing each public policy including a projection of the possible positive influence(s) each policy could have on the Bay region by the year 2020. In addition, each student is asked, as a BIG delegate, to evaluate the BIG Conference. Also included is an example of a final examination sheet that assesses the students' ability to apply their knowledge of various interest groups' points of view to specific Bay issues and to critique the students' critical thinking skills concerning a specific issue.

- *Activity 7: Debriefing and Evaluation of the Participants' Learning Experiences.* The participants step out of their assigned roles and once again as students they are asked to: (1) integrate the concepts and processes learned by the BIG Conference simulation experience; and (2) evaluate their personal learning experiences including achievement of the BIG Simulation Process Objectives and Skills.

As an optional follow-up activity, Appendix K outlines suggested *Applications to Local Environmental Issues.* Students are given the opportunity to apply the experience of the BIG Conference simulation to the study of local environmental issues.

Simulations

A simulation is an academic learning activity in which participants are given roles to play in a simulated environment. The objective is to learn how the environment works. Simulations are designed and used to give a participant's insight into the system or process being simulated.

The Bay Interest Groups (BIG) Conference simulation is an original model. However, the bargaining sessions use a model borrowed from Kenneth Smith and Ansell Horn of the University of Michigan Extension Gaming Service. This process of gaming can be used to design various games with different content. In this game the process itself has been modified and abbreviated in the Bay Interest Groups simulation. In real life, the parallel group to BIG is the Coastal Resources Advisory Committee (CRAC). The function of CRAC is to serve in an advisory capacity to the Coastal Zone Management Program. The Coastal Zone Management Program works with local government officials through a division of the Department of Natural Resources for the state of Maryland. Please see Figure 1 for the organizational layout.

Research has indicated that simulations motivate students and facilitate learning. There is a high level of personal involvement of the learner. This involvement is developed in small- and large-group activities that require the use of social and communication skills, important classroom goals.

The evaluation of student performance in a simulation game is more subjective than the testing that occurs during regular classroom activities. The primary purpose of the simulation is for the players to examine how decisions are made in the real world. Consequently, the teacher focuses more on the insights that students develop through group interactions than upon the individual.

Debriefing sessions usually follow a simulation. These sessions encourage open discussion of the content and the process learning that took place in the activities. The debriefing is an arena for free criticism of the gaming process itself, as well as the comparison of the game to real life.

Slow learners and underachievers are often motivated by the actual play of the game and feel a part of the group activity more than they do in conventional classroom techniques. High-ability students also respond very positively to opportunities for divergentthinking, and to the leadership they can provide for their assigned groups. The teacher becomes involved as a facilitator rather than an authority whose primary function is to dispense information. Outcomes of the game are decided by the players, not the teacher.

Additional background information for the teacher's use in the Bay Interest Group (BIG) Conference simulation can be ordered from the University of Maryland Sea Grant Program and the various state agencies.

Evaluation

A holistic approach to evaluation is recommended for this unit. The primary focus of the teacher should be to evaluate the quality of the overall experience, not the specific day-by-day activities. Suggestions for evaluating both the cognitive and affective domains of learning, outlined here, are detailed in the specific activities.

1. *Student Questions* are provided for use with the introduction to the Chesapeake Bay optional lessons found in Appendix J. Also, questions accompany "A Question of Balance" videotape presentation found in Activity 1. These questions can serve either to stimulate thinking or as a measure of cognitive learning following each presentation.

2. *Peer evaluation.* Activity 2 provides a form on which each student is given the opportunity of rating his/her group anonymously for cooperation and participation in the group activities. The form can be used by the teacher from time to time during the remainder of the simulation to monitor the progress of individuals and groups.

3. *Final report for the Department of Natural Resources.* Activity 6 requires a final report which is prepared both as an individual effort and as a group activity. The report consists of *(a)* the initially approved BIG Conference issues and public policies; *(b)* an outline of the environmental impacts which could result from each policy; *(c)* the proposals developed to mitigate environmental impacts; *(d)* the final approved public policies which incorporate the mitigating components; and *(e)* a projection of possible effects the final approved public policies could have by the year 2020. The report requires evidence of individual effort as well as group work. Criteria for evaluation of the reports include: *(a)* accuracy; *(b)* completeness; *(c)* documentation; *(d)* logic; and *(e)* participation. Logic and data-based arguments related to the defense of the issues and public policy positions rather than personal opinions are the critical factors which should be emphasized in the report.

4. *Critical thinking examination.* In Activity 6, an essay examination is provided to assess students' ability to apply their knowledge of the various interest groups' points of view to a specific issue associated with the Bay and/or critique the students' critical thinking skills in synthesizing a decision for the "best" course of action on resolving one or more issues.

5. *Questionnaire for the BIG Conference.* This questionnaire found in Activity 6 provides each student the opportunity to evaluate the effectiveness of the simulation experience as it models the real world. Students are also asked for suggestions to improve the BIG Conference.

6. *Debriefing.* Activity 7 encourages students to apply their newly acquired knowledge by comparing and contrasting the 1970 and 2020 land-use maps. A set of open-ended questions is provided for the purpose of assessing student ability to integrate the concepts and processes learned from the BIG Conference simulation experience. Secondly, a set of questions is provided for class study of "The Chesapeake Bay Agreement of 1983" and "Maryland's Chesapeake Bay 1984 Program Initiatives." The students are asked to analyze the agreement in terms of their understandings resulting from the simulation experience.

7. *Objective and skill achievement rating sheet.* This self-evaluation form found in Activity 7 can be used by students to assess their attainment of the unit's objectives and skills. The teacher can evaluate performance with the same form and then review the evaluation with the student.

8. *Applications to local issues.* All learning theorists agree that learning is maximized through application of the acquired skills and knowledge to new situations. Appendix K, Applications to Local Issues, suggests a variety of strategies that facilitate the study of local environmental problems. The students' interest in and approach to a local problem would reflect the perception and skills acquired during participation in the *Decision Making/The Chesapeake Bay* simulation. This in itself could serve as an evaluation tool.

ACTIVITY 1

Introduction to the Bay Interest Groups (BIG) Conference Simulation

Purpose

1. To familiarize the students with the BIG Conference simulation process.

2. To enable students to:

(a) Develop a balanced picture of the various points of view regarding the Chesapeake Bay;

(b) Identify interest groups and some of their concerns about issues that affect the Bay;

(c) Observe real-life people who relate to specific interest-group roles found in the BIG Conference simulation.

Time Frame

Two class sessions (minimum)

Materials

1. BIG Conference invitation letter
2. BIG Conference delegate roster
3. Cassette videotape "A Question of Balance"
4. Cassette videotape recorder/player

Procedure

1. *Invitation to the BIG Conference*

(a) Distribute to each student a copy of the BIG Conference invitation letter and the BIG Conference delegate roster. At this point, the teacher assumes the role of Conference Coordinator, A. Sydenham. By playing this role the teacher will be able to function as a facilitator for work performed by each interest group.

(b) After each student has read the material, discuss the goals of the conference. The flow chart presented above in the *Overview* can be used to outline the BIG Conference simulation experience step-by-step. Next, discuss with the students the amount of time you have scheduled for the in-class simulation activities. (You should be open-ended, if possible.) Also, if out-of-class work will be required (e.g., gathering additional data in the library, meeting with interest groups at other than class time). Students should be aware of their commitments.

(c) As time permits, have the students speculate about the concerns of the interest groups and individual delegates represented on the BIG Conference delegate roster. Indicate that class members will be assuming the roles.

2. *Presentation of the videotape "A Question of Balance"*

(a) Preview the videotape to become familiar with the content and issues presented by various individuals. The script is found in Appendix D.

(b) Prepare the students by discussing the following questions. Students will need to apply what they learned in Appendix J (if used) as well as draw upon other experiences. Included are examples of possible student answers.

QUESTIONS

1. *What constitutes a healthy Chesapeake Bay environment?*

(a) Continued growth and reproduction of the plants and animals of the Bay and the maintenance of healthy and balanced populations; (b) the Bay environment should have normal plant growth and cycles; (c) the water should be clean (not overly turbid or with a foul odor); (d) materials made by humans should not degrade the biota of the Bay.

2. *What are some signs that the quality of life in and around the Bay may be threatened? What do you think are some of the greater threats to the Bay?*

(a) Some of the Bay's aquatic vegetation is dying; (b) people who work the water report that finfish and shellfish production is decreasing compared to previous years; (c) siltation has caused some of the Bay and its tributaries to become too shallow for larger ships; (d) increased traffic on the Bay has released oil that fouls the water and affects the biota; (e) chemicals and heavy metals have interfered with oyster beds and spawning grounds near the sites where industrial effluents are disposed of in the Bay; (f) Virginia and Maryland have different laws concerning the harvesting of the biota. This inconsistency has contributed to a reduction in crabs, oysters, and clams; (g) some of the greater threats to the Bay are a lack of management and chemical pollution by industry and agriculture.

3. *What activities depend on the Bay and affect it directly or indirectly?*

(a) Direct activities: recreation, harvesting seafood, waste effluents, water transportation, home and commercial development (on Bay); (b) indirect activities: agricultural practices, mining, home and commercial development (away from Bay, but within the watershed).

4. *What groups of people do you think might be in conflict with each other over Chesapeake Bay management policy?*

(a) Many groups of people use the Bay. A great many political jurisdictions make decisions influencing the Bay. Concerns are often not with the biota of the

Bay but with business, recreational, and transportation concerns. (b) The "BIG Conference roster" lists interest groups and organizations that probably have different opinions of how to manage the Bay. For example, the environmental interest group would definitely have different concerns and ideas from those of the developmental interest group. (Note: if students do not refer to the roster, make sure you bring it into the discussion.)

(c) Follow-up discussion: spontaneous discussion may follow the videotape presentation. However, the questions below may be used to enhance the discussion. Included are some possible student answers to the questions. It may be profitable to prepare a study guide for student use during the presentation.

QUESTIONS

1. *What are some uses of the Bay? What problems may be related to these uses?*

(a) Uses are recreation, transportation, industry, harvesting, sewage disposal; (b) each of these uses can contribute to water pollution which in turn might lead to negative effects on the living organisms in the Bay.

2. *What is meant by water quality? How can various uses of the Bay affect water quality?*

Water quality is a measure of dissolved or suspended components in the water. Poor water quality is measured by the amount of undesirable components in the water: chemicals, sewage, runoff of chemical nutrients, silt, harmful microbes. Better water quality is the lack of these components, or less of them.

3. *What is the Chesapeake Bay Foundation's role in using the Bay?*

Conservation education in the Bay region and legal assessment and action.

4. *What is Bethlehem Steel doing about environmental controls on steel manufacturing?*

Bethlehem Steel increased the height of the smokestacks and improved the filters to cut down on the amount of wastes that flow into the Bay.

5. *How do the watermen see their use of the Bay as compared with other groups?*

The Bay is their livelihood; other groups either use the Bay for recreation or for development.

6. *What roles are performed by the Department of Natural Resources?*

DNR oversees the natural resources systems that are under state government supervision.

7. *Generate a list of feelings, attitudes, and opinions expressed by the groups using the Bay.*

These would be the individual interests of each group as well as the different ways that each group strives to work for better management of the entire Chesapeake Bay ecosystem. Each interest group thinks that it is doing the correct thing.

8. *Why do electrical power generating plants need to be located on the Bay and its tributary rivers?*

Water is needed to cool the electrical generators.

9. *What effect does dumping sewage into the Bay have on the water quality and life? What can be done about this problem?*

(a) Sewage overloads the Bay's waters with too many salts, nutrients, microbial organisms, chemicals, etc. and causes either an overgrowth of aquatic plants or a weakening of the aquatic animal life cycles and reproductive habits; (b) sewage can be treated and sprayed on the land in non-food-production areas, or more expensive equipment can be added to the existing treatment facilities to further break down these materials. Some components, such as the heavy metals, are difficult to convert to a usable form.

10. *Who must be involved in solving the problems of the Chesapeake Bay?*

Each interest group, each person who uses the Bay, either directly or indirectly, must concern him/herself with solving these problems.

11. *Who has final responsibility for the Bay?*

According to the narrative, any individual or group who uses the Bay. (Note: it is important to refer again to the "BIG Conference delegate roster" and explore the represented interest groups and individuals.)

12. *What is currently being done by industry, power companies, fishers, etc. to preserve the Bay?*

Although some laws and guidelines are enacted to better manage the Bay, much more must be done in order to keep the Bay healthy.

13. *What is the challenge and responsibility to you as a citizen of the Bay area?*

We must identify the sources of pollution, follow uniform guidelines, and manage the Bay. We must clean up the Bay through both direct cleaning and indirect methods of identifying the nonpoint sources of pollution and stopping them before they flow into the Bay. (Note: Following discussion of items 10-13, the teacher should make reference to Maryland's Chesapeake Bay Program Initiatives, passed by the 1984 Maryland General Assembly, to clean up the Chesapeake Bay. Refer to Appendix I for further information concerning the initiatives, but postpone discussion until Activity 7, the debriefing session.)

14. *What are some factors to consider when determining where a factory or industrial plant should be built?*

One should ask the following questions: (a) Can the construction of the industry be done without upsetting the balance of the Bay? (b) Will the effluent foul the Bay? (c) Can the industry use the facilities without destroying the organisms in the Bay?

15. *Why is the management of the Bay such a complex problem? What suggestions are given in the videotape for who should manage the Bay?*

Each person has a tendency to adhere to his or her own view. Different groups must work together for the overall management of the Bay using technology, despite monetary expense, to clean up the Bay. Political jurisdictions must have common laws to apply throughout the Bay that are compatible with the best interests of the Bay's ecosystem.

16. *How may the increasing human population affect the Bay?*

Increasing population affects the Bay in the following ways: More people create more development and industry which either directly or indirectly dump more materials into the Bay. People will need to change their habits and become more aware of their responsibility for litter and pollutants; they will need to find more effective ways of disposing of waste materials.

With the background information supplied in Appendix J (if used) and this videotape presentation, the students should be sufficiently informed about various viewpoints and interest groups to proceed with the BIG Conference role assignment and issue selection found in Activity 2.

ACTIVITY 2

Role Assignment and Issue Selection

Purpose

1. To assume roles for the BIG Conference simulation.

2. To bring together interest group members for the purpose of establishing common sets of interests and concerns.

3. To conduct initial issue research.

4. To synthesize individual viewpoints on critical Bay issues into an interest group consensus.

5. To take a stand by discussing and debating the Bay issues with other interest groups.

6. To select Bay issues for further research and policy development.

Time Frame

Role assignment: one class session (minimum)
Issue selection: two class sessions (minimum)

Materials

1. For issue selection process:

- 20 4″ × 6″ cards marked 1-20
- 84 voting chips

2. *Chesapeake Bay Data Bank,* one set for each group.

3. The following student handouts, found in the student materials section:

- Bay Interest Groups Conference delegate roster
- BIG Conference agenda
- Individual delegate role descriptions
- List of the twenty Bay issues
- *Chesapeake Bay Issues—Defined* (Note: for teacher information, a more elaborate definition for each issue is found in Appendix E.)
- *Chesapeake Bay Fact Sheet* (optional distribution through lesson found in Appendix J)

Procedure

I.
Role Assignment and Initial Issue Research

1. Distribute to each student the packet of handouts (or present them on an overhead projector).

2. Read the handout "BIG Conference Agenda."

3. Review the Bay Interest Groups Conference membership list of delegates and organize the class into interest groups. Either assign or permit students to choose their interest groups and their individual roles. The options are:

(a) Permit the students to negotiate to choose the roles they would prefer.

(b) The teacher can assign the roles randomly.

(c) the teacher can assign roles based on insights into student personality, motivation, ability, interest, previous experience, and parent occupation.

There are no "bad" roles and this should be emphasized with students. All roles are viable and important. Point out that everyone can learn a great deal by "wearing the other person's shoes."

The roles as written should be assumed by the students. One interest group, the scientists, should be monitored closely because of the way some groups interpret the role scientists perform in our society. They think that scientists should be totally objective without opinion; to serve only as disseminators of information to others who are responsible for decision making. In the BIG Conference simulation the scientific roles are to be played as real people with opinions (as was illustrated in the videotape). The scientists can provide information to other interest groups, but their main purpose is to influence development of public policy that appropriately reflects the concerns of the scientific community.

Another interest group, the industrialists, may find it difficult for the members of other interest groups to accept their views on some of the issues. Students who are creative with positive social skills may play the roles in this interest group well.

Because the private interests group is diverse in nature, group cohesiveness may develop more slowly than in the other groups. The teacher should provide them with extra support and guidance.

Post on the classroom bulletin board a list of the roles with space for the students to fill in their names next to their assigned or chosen roles.

To provide easy identification of groups and to enhance group cohesion, a symbol could be used for each interest group. This could be a name plate, picture, or a real item (i.e., "play" money for the developers; microscope for the scientists) provided by the individuals in the interest groups.

Following role assignment, allow five to ten minutes for each individual to read about his/her role. Stress that the individual is to become the person, suppressing his/her own personality, interests, and concerns as much as possible. To facilitate role identification, a worksheet as outlined could be prepared for use by each student. The worksheet could be followed by a letter written by the student to explain his/her background and stand on Bay issues in response to an inquiry by a fictitious reporter.

BIG Conference Role Discussion Sheet

Name: ______________________

Interest group name: ______________________

Organization: ______________________

Your assumed name: ______________________

Background Information on your role: ______________________

____

____

Your interests on the Bay: ______________________

____

____

Bay interests you are concerned with	Possible allies (from other interest groups)	Possible opponents

Another activity found to be very informative is to invite to class individuals who represent the various interest groups. An alternative would be for each student or interest group to schedule an appointment with one or more individuals in the community that represent the special interest. The interview form, as illustrated, has been used to organize an interview.

Interview Form for Visiting Representatives of Special Interest Groups

Name: ______________________

Name of person being interviewed: ______________________

Occupation: ______________________

Questions:

1. What are you concerned about with respect to the Bay?

2. What changes/maintenance programs do you want to see made for the Bay region?

3. How do you think people in your profession stand on these issues? (Write their responses on the back.)

1. Recreational Boating
2. Commercial shipping
3. Dredging and Disposal of dredge
4. Harvesting aquatic resources
5. Tidal and nontidal wetland
6. Shore erosion
7. Use of flood plains
8. Use of Agricultural lands
9. Beach access
10. Onshore oil and natural gas facilities
11. Electric generating facilities
12. Ports
13. Industrial Parks
14. Residential Development
15. Sewage treatment faciolities
16. Land transportation facilities
17. Forested lands
18. Mineral extraction
19. Channelization
20. Recreational, open-space, and natural area

What special interest groups do you find that are in sympathy with your Bay interests? Those that are opposed?

Next, have the students confer with the other members of their interest group to get to know each other's role and to share viewpoints. After 10–15 minutes, ask each interest group to introduce itself to the Conference by saying a few words about its common background and interests. Each individual should be introduced and encouraged to emphasize his/her particular point of reference.

The next step is for each interest group to begin identifying common concerns. They should address the questions:

> How much should the Chesapeake Bay be developed in the next five years?
> By the year 2020?

To facilitate the discussion, each group should now peruse the twenty defined issues. If the *Chesapeake Bay Fact Sheet* was not used as part of the lesson found in Appendix J, it should now be distributed to the groups. Ask the interest groups to read or reread the Fact Sheet. This time, instead of merely answering the study questions, have the students define the issues by using the information provided in the Fact Sheet. If time is running short, the task can be given as a homework assignment. The next activity will ask the groups to formalize their views on the importance of each issue.

II.
Issue Selection

1. Students meet in their interest groups and share views on the issues.

2. Interest groups determine the importance of each issue and pick those issues they wish to have selected for further study by the BIG Conference.

3. The interest groups, through negotiating and voting, select four issues by using one of the following procedures. After the four issues have been selected, each interest group researches and prepares a public policy statement for each issue. (Note: It has been verified that the simulation works best when four or more issues are selected, but it is true that students can fully profit from working with only two or three issues.)

Issue Selection Process

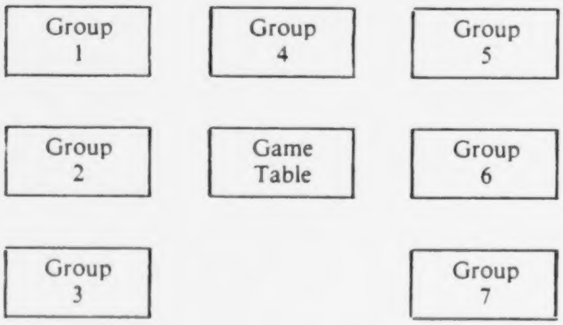
There are four alternatives for selecting the four Bay issues. Pick one.

1. *Teacher selects issues.* The teacher, playing the role of the conference chairperson, can select for study four of the twenty issues. If the teacher chooses this course of action, he/she will skip this activity and begin with Activity 3, "Researching the Issues and Policy Design." A teacher should choose this option only to save time or to guarantee study of issues related to previous or potential follow-up classroom activity.

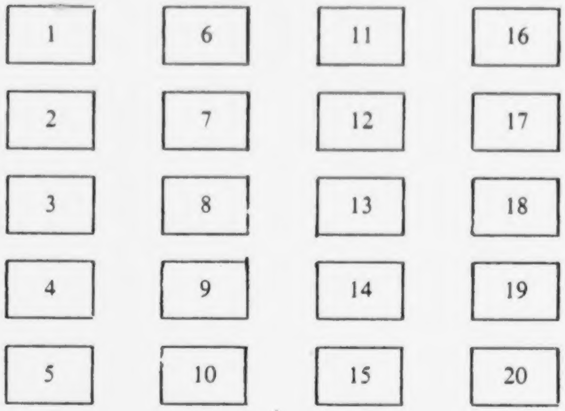
2. *Short bargaining and voting session.*

(a) Provide each interest group with 12 voting chips, or as an alternative ask each group to come up with 12 items that can be used as votes (e.g., play money for private interests, clam shells for watermen). The game table is set up in the center of the room with issue cards numbered *1* through *20* displayed on the table as illustrated:

Room arrangement



Game table arrangement



(b) Interest groups are given a minimum of twenty minutes to bargain, compromise, negotiate, and/or form coalitions with each other to support specific issues.

It should be emphasized repeatedly with the students that groups should negotiate and bargain based on the identified concerns of the group, not based on personal views or biases. A teacher might choose this short bargaining and voting session over the long session to save time. However, the long bargaining and voting session described next provides for more elaborate debate of the issues. The use of the *Chesapeake Bay Data Bank* and the *Fact Sheet* should be encouraged during this time so that each interest group has a more accurate information base on each issue. It is recommended that you, as chairperson of the BIG Conference, discuss with the students why negotiation and compromise are essential parts of the simulation. Both processes produce a situation where groups can benefit by having their interests represented in the final vote or decision. Later, when policies are generated and voted on, bargaining skills will again play a critical role in forming policies for final study.

(c) At the end of the bargaining period each interest group will give the conference chairperson a ballot indicating the placement of its chips. (The group may wish to place all 12 chips on one issue, or it may have bargained with another interest group to place a certain number of chips on one issue and the remainder of the 12 chips on another issue.) The four issues with the largest number of voting chips are selected for further study. In case of a tie, all conference participants will vote by a show of hands. Before any hand vote there should be a brief discussion since the two issues may not have been previously considered by all groups.

3. *Long bargaining and negotiation session.* The game table is set up the same as in the short bargaining session. Each group again receives 12 voting chips. A total of four issues will be chosen for further study. In order to gain support for the issue(s), each group must negotiate, compromise, and ally with other groups whose interests are similar. Again, provide at least twenty minutes for this initial activity. During the first voting session each interest group writes its vote(s) on a ballot and hands it to the chairperson, who then directs the placement of the voting chips. The issue card that receives the highest number of votes is selcted. Voting sessions (not including bargaining time) should be held to three minutes.

All remaining bargaining and voting sessions will be played as follows:

(a) Begin with bargaining session (five to fifteen minutes).

(b) Vote for the next issue. As before, each interest group has the freedom to divide its chips and place them on more than one issue. This makes bargaining and decision making difficult, but similar to real-life practices.

(c) Continue bargaining and voting sessions until four issues have been selected for further study.

4. *Combination of teacher selection and student selection.* The teacher for various reasons may want to insure that one or more issues is set aside for study. Additional issues are then selected by either short or long bargaining and negotiating sessions.

Special considerations

1. Make sure that the time limits for bargaining and voting are closely adhered to, or the students will not come to closure. Use an alarm timer, gavel, or other device to signify the end of the session.

2. Bargaining sessions can become very loud and may require special arrangements. For example, in an open-space school, the teacher may wish to move to an area where they will not disturb other classes. Inform your principal or department head about the purpose of the sessions.

3. Voting should be confidential and should take place rapidly. Allow the students only three minutes to vote, with only one group member responsible for bringing the ballot to the chairperson. Reject ballots that arrive late.

4. Stress that students should stay in their roles and look at issues through the eyes of that person. Personal opinions should not enter into the bargaining. Reemphasize that there are no "bad" roles.

5. Require at least one student to remain at the interest group's table. This will insure a contact for negotiating and bargaining.

6. Interest groups that did not have an issue selected will naturally be disappointed. It is important that the groups be reassured that they can have a major impact at a later time when policies are prepared and when the policies are submitted to environmental impact analysis. Indicate that in real life the opportunity to influence decisions may only occur at the end of a long process. Encourage the students to do their "homework" and prepare a strategy for the following sessions.

7. *Peer evaluation form.* Much of the success of the BIG Conference simulation depends on effective group participation. It is important that the members of each interest group do their share in all group activities. A peer evaluation form may be used periodically throughout the simulation as feedback to the teacher. Students anonymously rate their group for cooperation and participation. These evaluations can be used by the teacher to detect potential problems within a group. The data can be summarized and shared with students. This procedure may be particularly valuable to the teacher assisting the members of a group to work well together. The form shown here could be used from time to time throughout the simulation experience to monitor the progress of individuals and groups.

Process Assessment Form

______________ Interest Group

Rate your group on the tasks below by circling the best description. The group will not be graded on these ratings.

I feel for the most part that the members of my group:

1. Assume and play their roles well.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagress

2. Perform appropriate research for the task at hand.

Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree

3. Share the work fairly.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

4. Can be depended upon to complete assigned tasks on time.

Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree

5. Contribute effectively in decision-making.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

6. Participate in discussions with the group.

Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree

7. Represent the group well when bargaining and negotiating with other interest groups.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

8. Work well together as a team.

Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree

9. If you feel the need, please use the space below to comment on any of the above aspects of your group's activities.

10. Please use the space below for additional comments or questions you might have about the BIG Conference simulation. In particular, please share your thoughts about your group's interactions with other groups and how you feel about the simulation in general.

ACTIVITY 3

Public Policy Design

Purpose

1. To develop skills for writing public policy.
2. To complete in-depth research on the four selected Bay issues.
3. To develop a public policy statement for each of the four issues.

Time Frame

Two class sessions (minimum)

Materials

1. Appendix F: "Public Policy: Action Format and Examples of Public Policy Statements."
2. Appendix A: "Topic and Issue Cross-References: The Chesapeake Bay Data Bank."
3. The *Chesapeake Bay Data Bank.*
4. Student Materials: "Memorandum—Re: Public Policy Statements for the Selected Issues."

Procedure

1. Present the information found in Appendix F so the students can learn to develop reasonable public policies:

(a) Define environmental public policy.

(b) Discuss what elements must be considered in developing a public policy statement. These elements should include: *Issue statement*—statement of the particular Bay issue selected for study; *goal statement*—a statement of what you would like to see happen regarding the issue; and *methods*—a statement of what methods you would use to achieve your goal, including advantages and disadvantages of each method (for example, moral persuasion, torts, prohibition, etc.).

(c) Present a variety of examples of public policies for specific issues.

(d) Give the students an issue, and, either as a class or as individuals, have them write at least two public policy statements. Critique the policies as a class activity.

2. Present and discuss an overhead transparency of "Memorandum: Public Policy Statements for the Selected Issues" (each interest group should have a copy of this memorandum for future reference).

3. Have each group research the issues, form positions on the issues, and design policy statements to reflect their viewpoints. The students should use the *Chesapeake Bay Data Bank* and other authoritative sources to develop and justify their policy statements.

The *Chesapeake Bay Data Bank* and other authoritative sources should be emphasized with the students as an essential tool for researching the issues. You should insist that the interest groups consult the data bank extensively in developing and justifying their policies. Unless this is done, the policies will lack legitimacy. Appendix A contains two cross-references that will prove useful to you as the chairperson in facilitating interest group access to the data bank. You should *not* give the interest groups the cross-references. Instead, you, as the resource person, are to show them how to use the data bank in their search for relevant "data." Your assistance may be as simple as insisting that a group use the table of contents or as difficult as helping in synthesizing conflicting data.

For lower-ability students, instructors have found it useful to leaf through the Data Bank, as a study activity, with the entire class. Information that relates to each selected issue can be identified and discussed, including the varying relevancy that some material may have for different interest groups. Also, it is a good idea to create a folder as a supplement to the Data Bank for each selected issue. The folder can be filled with recent publications, news articles, brochures, and other references that provide up-to-date information. Reading materials should be selected that are well written and at the appropriate reading level. The bibliography in Appendix C lists some materials which may be acquired for the folders.

4. Assign each group to write a policy statement for each of the selected issues on a standard form like the one illustrated and turn them in to you at the end of the activity or as a homework assignment to be collected at the next session. Each public policy statement should be no longer than three or four sentences. Remind the students to use the recommended format for developing public policy statements with the following specific information: interest group name, policy number (1–4), issue under study, the goal statement, the method or methods employed, the public policy statement and resources cited. Unless you carefully structure the process, some students will turn in the assignment with varying degrees of completeness.

BIG Conference
Public Policy Statement

Interest group name: ____________________ Policy No. ___
Issue: ________________
Goal: ______________________________
____
Methods: ______________________________
____
Public policy statement: ______________________________
____
____
____
Resource citations: ______________________________
____

5. The teacher should number and prepare the list of policy statements in the following way for distribution in the upcoming bargaining and voting sessions in Activity 4. Try to limit the seven policies for each issue (one from each interest group) to one page, making a maximum of four pages. Each set of policies for each issue can then be easily compared for similarities and differences. Identify the policies by interest groups.

- Page 1—Policies 1-7—all for Issue 1
- Page 2—Policies 8-14—all for Issue 2
- Page 3—Policies 15-21—all for Issue 3
- Page 4— Policies 22-28—all for Issue 4

ACTIVITY 4

Policy Presentation and Selection

Purpose

1. To have each interest group present, discuss, and debate with other interest groups its public policy statements prior to the bargaining/voting process.
2. To engage the students in bargaining and negotiating for specific Bay public policies.
3. To select through compromise and voting four public policies for further research.

Time Frame

Policy presentations: one class session (minimum)
Bargaining, negotiating, and voting on policies: two class sessions (minimum)

Materials

1. Game table with 28 cards numbered *1-28,* one card marked "For," one card marked "Against."
2. 84 voting chips (each of the seven groups receives 12 chips).
3. List of 28 policies (one copy per interest group).
4. Student Materials: "Memorandum—Re: Policy Voting Procedures."

I.
Policy Presentation

Procedure

1. Distribute the list of 28 policies to each interest group. Also post copies on the bulletin board. Provide time for each group to review the policies.
2. Have interest groups present a justification for each of their policies. Limit each group to five minutes. As an alternative, the chairperson can make the presentation.

Interest groups should be encouraged to take notes on the justifications offered for policy statements. This may be helpful in the bargaining/voting sessions that follow. Encourage questions so that there is a full understanding of the policies.

3. Assign "Memorandum—Re: Policy Voting Procedures." Explain the different voting session procedures as outlined in this memorandum to the students.

II.
Bargaining, Negotiating, and Voting on Policies

Activities

1. For the 28 policies, each interest group develops a strategy that includes the following:

(a) Those policies, other than its own, that can be supported by the group;

(b) Those policies that cannot be supported, along with its reason for nonsupport (preferably based on information obtained from the *Chesapeake Bay Data Bank* and other resources);

(c) A list of those interest groups with which it might be able to form a coalition to increase the chance that preferred policies will be accepted in the final vote.

2. Bargaining and voting sessions are held until at least one policy has been selected for each of the four issues. Before the final voting round, each interest group has the option to amend, at any time, one or all of its policies. Recommendations from other interest groups should be given careful thought before revising policies. Compromise is generally necessary. All amendments must be reported to the chairperson before a policy can be voted onto the agenda or receive a final vote of acceptance. Each amendment should be written on the chalkboard so that each interest group can edit the original policy found on its own copy of the ditto.

Procedure

The interest groups vote on policies that the BIG Conference will be presenting to the Maryland Department of Natural Resources in the following manner:

1. All 28 policy statements are represented on the game table by numbered cards. Add two more cards, "For" and "Against," for registering the final acceptance vote. The game table is arranged as follows:

1	8	15	22	
2	9	16	23	
3	10	17	24	For
4	11	18	25	
5	12	19	26	Against
6	13	20	27	
7	14	21	28	

Each interest group records on a ballot the interest group's vote for selected policies. All ballots are then handed to the BIG chairperson, who directs the voting chip placement onto the appropriate policy cards.

2. In the initial voting rounds, the interest groups may need time to further research the Data Bank and other resources to build a strong case for their policies and/or find evidence to refute the policies of other interest groups. This time could also be used for the groups to interact and work out compromise policies. The students should follow the rules given in "Memorandum—Re: Policy Voting Procedures." The play of the game will be more complex and time-consuming than when issues were selected. Bargaining will take place between each round of play. The interest groups will play as many rounds as it takes to agree upon at least one policy statement for each issue. Because it is possible for an issue to be represented by more than one policy statement, the issue with multiple policies should be reconsidered. Policies need to be either combined, compromised, or eliminated by discussion and open voting of the BIG delegates until the issue is represented by only one policy statement. The BIG chairperson can make a final decision in cases of dispute.

3. Following the voting of a policy onto the agenda and after its acceptance, it is a good idea to reread these policies to the entire conference. With all the interaction occurring, students may lose sight of the policy approved for presentation to the Department of Natural Resources.

ACTIVITY 5

Environmental Impact Statements

Purpose

1. To explore the Environmental Impact Statement (EIS) process.

2. To prepare an EIS for each public policy.

3. To mitigate the negative impact(s) of each approved public policy.

Time Frame

Two class sessions (minimum)

Materials

1. Appendix G: "Environmental Impact Statements—Their History and Purpose."

2. "Memorandum—Re: Assessing the Environmental Impact of the Chesapeake Bay Public Policy."

Attachments: (a) "Environmental Impact Statement Grid"; *(b)* "Preparing the Environmental Impact Grid."

3. EIS Grid transparency

4. Transparency marking pens (red, orange, yellow, black): 4 sets—one set for each subcommittee.

Procedure

1. For teacher background, read "Environmental Impact Statements—Their History and Purpose" (Appendix G).

2. As chairperson, introduce the activity by first reviewing briefly the four approved public policies.

3. Hand out and read the "Memorandum—Re: Assessing the Environmental Impact of Public Policy." Attached with the memorandum is the Environmental Impact Grid. Each interest group will assess the impact of each public policy on the Bay environment by the year 2020. Instructions for completing the grid are outlined in the document "Preparing the Environmental Impact Grid."

4. Complete the EIS Grid. The interest groups will require your guidance in adequately researching the impacts. Insist that they readily consult the Data Bank and other authoritative sources.

(a) The interest groups will use the enclosure "Preparing the Environmental Impact Grid" to compare existing conditions in the environment and the possible effect that each of the four policies will have on each of the conditions.

(b) Interest groups should use the same grid for each of the four policies. Several of the criteria suggested may not be applicable to a policy under discussion; therefore, have the interest groups first examine each proposed action to determine if it is a part of the policy, and thus would have an impact on the Chesapeake Bay environment. A check-off space is provided beneath each proposed action.

To save time, the teacher may wish to point out those actions which are obviously inappropriate for each of the policies, giving a short rationale for the inappropriateness.

(c) After researching the environmental impacts of each policy, each member of each interest group will vote on the impact which the proposed policy will have on the environmental characteristics and conditions of the Chesapeake Bay environment.

The individual will vote 0-3 for each appropriate square in the grid according to his/her estimate of the impact:

0 = no impact at all;

1 = slight impact (some changes, but not negative ones);

2 = moderate impact (quite a few changes, some of which are negative);

3 = severe impact (many changes, most of which are negative).

Each interest group computes an average, which is then written in the appropriate square of the grid to indicate the severity of the impact.

(d) After each interest group has determined the impact of the four public policies, four subcommittees (composed of one or more representatives from each interest group) will meet to synthesize a consolidated grid response which represents BIG's position.

Using an overhead transparency of the grid, each committee should write with black pen on each appropriate square the *sum* of the numerical values from the seven interest groups. The square will also be color-coded according to the following scheme:

0—7	yellow	no impact, or slight impact
8-24	orange	moderate impact
15-21	red	severe impact

(e) In each instance where the sum is 8 or greater, the committee needs to propose ways to mitigate (or minimize) the harmful impact of the policy on the Bay environments and devise guidelines for implementation. These proposed mitigations will be reported back to all members of the BIG Conference for consideration. The transparency should be projected, to illustrate visually the various impacts.

Each individual then votes to either approve or reject the mitigated policy and its EIS. A simple majority is required for approval. If not approved, the committee must reconvene and work out a set of compromises acceptable to the majority of the BIG delegates.

ACTIVITY 6

Preparation of Final Report and Evaluation

Purpose

1. To prepare a final report for the Maryland Department of Natural Resources.
2. To evaluate individual student ability to apply obtained knowledge and use critical thinking skills.
3. To evaluate the BIG Conference simulation experience.

Materials

1. EIS transparencies from Activity 5
2. Student-generated materials for Final Report
3. "Questionnaire for BIG Conference"
4. Appendix H, "Example of a Final Report"

Procedure

I.
Final Report

1. *Final Report format.* Each interest group prepares a final report for the Maryland Department of Natural Resources. This requires the synthesis of the previous work for developing each public policy, including information found in the grids, mitigation statements, and policy revisions. The report contains four sections. Each section deals with one of the Bay policies and consists of five components.

(a) Issue and public policy statements as originally approved by BIG.

(b) An outline of the specific negative and positive impacts the policy could have on the environment (as interpreted from the consolidated grid and from discussion prior to approval).

(c) The agreed-upon proposals to mitigate (or minimize) the negative environmental impacts of the policy.

(d) The final approved public policy which incorporates the mitigating components.

(e) A projection of the possible positive influence(s) the integrated public policy could have on the Chesapeake Bay region by the year 2020.

Components *(a)* through *(d)* summarize what has already occurred. Interest groups can enhance their reports by including Data Bank references to substantiate statements and decisions. The projections to the year 2020, component *(e)*, should be based upon what the interest groups have learned from their study of current conditions as outlined in the Data Bank. Information helpful in the preparation of final reports can be found in Appendix H.

2. *Final Report evaluation.* Students should work as interest groups, not as individuals, in preparing the final report. A group grade may be given to each interest group for the written report. There should be evidence of group work in all phases of developing the report.

The teacher, as facilitator, may wish to discuss with the students the problem of some individuals participating less than others. When group grades are given, peer motivation should encourage individuals to participate more fully. The teacher may wish to circulate among the groups and interact with students as part of the overall evaluation. By the time the teacher has read the final reports, he/she should be well acquainted with how each interest group interacted in preparing its report.

In some instances, it might be appropriate to give individual grades. Individuals may be assessed through their completion of assigned specific tasks. For example, a student could have the responsibility of drafting one of the five components for each policy. The teacher can then collect this draft for evaluation prior to discussion by the group. It is recommended that individual grading occur only if a significant number of students are not working well together in the group process, which is unlikely by this point in the game.

Any evaluation procedures that the teacher chooses should be outlined for the students prior to this activity (preferably during Activity 3). Students should know what is expected of them and how they will be evaluated prior to writing their reports.

It is not appropriate here to recommend a specific grading scheme. The scoring of the reports, because of their somewhat subjective nature, should reflect the amount of time and effort spent on the different activities, the various ability levels of the students, and the goals of the teacher. Criteria for evaluating the reports could include:

(a) Accuracy—public policies, mitigating statements, environmental impact statements, etc., should be reasonably accurate.

(b) Completeness—all five components should be included and appropriately sequenced within the report. Each public policy and mitigation statement should contain sufficient information to comprise a complete report.

(c) Documentation—all information and mitigated policies should be reasonably referenced from the Data Bank and/or other sources.

(d) Logic—predictions should be based upon what is currently known as well as on documented projections to the year 2020.

(e) Participation—all delegates within the group should cooperate with each other to a reasonable extent in preparing the report.

Reports should be evaluated as soon as possible and reviewed with the class at the first opportunity, pointing out the strengths and weaknesses of the reports.

Each interest group should be encouraged to defend its position statement concerning projections to the year 2020, as well as be open to constructive criticism and supplementary suggestions. Logic and issues rather than personalities should be emphasized.

II.
Evaluation of Individual Effort

You may desire to give a final examination that assesses the students' ability to apply their knowledge of the various interest groups' points of view to a specific issue associated with the Bay and/or critique the students' critical thinking skills in synthesizing a decision about what to do concerning a specific issue.

The following example of an examination, developed by Mr. Ed Nawrocki, Howard High School, has been used quite successfully as a way to evaluate *Decision Making/The Chesapeake Bay.* Ed reports that his students enjoy very much responding to the examination questions.

Final Exam: *Decision Making/The Chesapeake Bay*

In this exam, you will be given 3 sets of data: (1) **Bay Impact:** This will provide you with current information that is factually accurate; (2) **Personality Profiles:** This will provide you with a set of information about 3 individuals you will have to become. You must think like these people when answering parts pertaining to them; (3) **Situation on the Bay:** This will give you hypothetical information of a possible situation on the Bay. Treat it as if it were really true for this exam. (In fact it is only partially true!)

After studying all the data, answer each question as instructed.

The Coastal Resources Advisory Committee is calling a hearing to investigate the concerns of commercial fishermen and ecologists that the nuclear power plant operated by the Chesapeake Bay Power Co. at Solomon's Island is rapidly harming the Bay ecosystem.

The BIG, an advisory organization to which each of these 3 concerns belong, has issued the statement *Situation on the Bay—June, 1985.*

The Coastal Resources Advisory Committee has requested that the Chesapeake Commercial Fin Fishing Association, the Save the Bay Foundation, and the Chesapeake Bay Power Co. each send a representative to make a statement at the hearing. Each of these individuals knows that his/her comments could greatly influence the decision of CRAC and the future of the nuclear power plant on the Bay.

1. On test item #1, respond as the Chesapeake Fin Fishing representative.
2. On test item #2, respond as the Chesapeake Power Co. representative.
3. On test item #3, respond as the Save the Bay Foundation representative.

Chesapeake Bay Power Co.

You are director of the Research and Development Division of the Chesapeake Bay Power Company. From an inside viewpoint, you determined that the country's use of energy would keep increasing. Until the last several years, though, you thought that it would be a matter of simply building more generators to satisfy the increased demands for power. You were instrumental in the design of the first atomic power plant on the East Coast. You are proud of that accomplishment—but then some environmental groups began telling the public that these plants were dangerous and your accomplishment seemed no longer a thing to be proud of.

You have said to the press previously, "I think that it's a bit unfair, all of these complaints. It's not like the power companies are creating a false need. It's not like we're a bunch of money-grubbing scoundrels. If the public wants to use its blow-dryers, electric knives, air conditioners, microwave ovens, and televisions, we have to generate the electricity to allow them to do it. The public indirectly tells us how much power it wants and it is up to us to give it to them—by building new generating plants. People don't want the dams for hydroelectric power. They don't want the dirty air from the fossil burning plants. Solar energy, unfortunately, doesn't seem feasible at this moment. It's either nuclear energy or turning off the utensils."

Chesapeake Commercial Fin Fishing Association

You have run a fishing boat out of Annapolis for the past ten years. You know that the Chesapeake Bay has natural cycles, so you were not too surprised when the past year's rockfish spawning was a failure, producing fewer rockfish than any year since 1963. Also you were not particularly surprised that the alewives have all but disappeared and the blueback population is on the decline, as are the number of herring, whitefish, and hickory shad.

Anchovy production is dropping rapidly, you are sad to learn, while a fish you despise, the bluefish, is increasing rapidly in numbers. This will lead to more fouled lines and torn nets. You and the other fin fishermen feel that the huge populations of bluefish have invaded the Bay and left after a couple of years. This has been their longest stay. You are beginning to feel that what is happening may not be a natural occurrence, but instead might be attributed to pollution and overuse of the land, and a change in feeding grounds because of thermal pollution.

Save the Bay Foundation

You are Director of Save the Bay Foundation. As a lifelong resident of the Bay region you have grown up regarding the Bay as a friend. Many an afternoon has been spent walking the sandy shoreline or sailing the quiet, clear waters. In the last ten years you have watched with growing sadness as the quality of the Bay has slowly deteriorated; the waters are less quiet, and the sandy beaches less clean. This has all come about as this beautiful country has been inundated by people and industry who lack the sense of caring which you have.

Your deep feeling about the Chesapeake Bay has forced you to devote all your time and energies into founding and directing the Save the Bay Foundation. It is obvious that the only way to return the Bay to its pristine condition (as you remember it as a child) is to stop the mass movement of people to the region. This can be done by preventing industries from coming to the area, reducing the recreational outlets available, stemming the tourist flow, and making it difficult for new housing to be built.

Bay Impact

Agricultural run-off, excess sewage, storm water run-off, and industrial discharges have had measureable adverse effects upon fisheries in the Chesapeake Bay and its tributaries.

The extent of stress on the living resources in Maryland's aquatic coastal environment is not fully known for several reasons. First, there has often been inadequate basic data of the aquatic biota. Second, there is currently no method which adequately detects changes in the health and integrity of the biota in Maryland's coastal zone.

Situation on the Bay—June 1985

There has been some concern on the Bay in Calvert County. The measured temperature increase around the Solomon's Island Nuclear Power Plant is approximately 5° F. This is producing a "spot" influence on the flora and fauna in the immediate area. Organisms such as plants, oysters, and clams, which are sessile (nonmoving) are being affected. Some grasses which are used as food sources and protection for young fishes and crabs are actually dying off, as are young oysters and clams. However, this situation is actually increasing some grasses (of no apparent use to fish and crabs). It is also increasing the size of older oysters and clams.

Along with the increase in water temperature, the feeding grounds for many fine sport fish, such as rock, spot, and perch, has shifted down the Bay several miles. There is an increase in bluefish population. So the large money fish have been replaced by more plentiful but less desirable fish.

In addition to the above, there has been an increase in algae in shallow waters. This is removing oxygen from the water and this usually has a bad effect on the fin fish and crab populations. This accumulation of algae is inhibiting the growth of "subaquatic vegetation" which provides sanctuary for young estuarine organisms (fish, crabs, oysters, etc.).

On the whole, research suggests that these things are indeed happening, but because of the lack of good data, many knowledgeable

Bay people feel that these changes may only be temporary until the species involved adapt to the new Bay environment.

1. Your response as the Chesapeake Commercial Fin Fishing Association representative (remember your livelihood is at stake).

2. Your response as the Chesapeake Bay Power Co. representative (remember your career is at stake).

3. Your respose as the Save the Bay Foundation representative (remember you feel the Bay is at stake).

Finally, you are chairperson of CRAC. You were appointed to the committee by the governor, but elected chairperson by a majority vote of CRAC members. There are 8 members on the committee other than yourself. Four people vote to allow the Power Company to continue operations unchanged, four vote to close it down until more information is obtained (two years at least).

You must cast the deciding vote for a simple majority rule. Tell how you would vote and justify your decision considering the "Bay Impact" and "Situation on the Bay—June 1985" statements.

III.

Questionnaire for the BIG Conference

The following questionnaire, adapted from a meeting evaluation form used by the Coastal Resources Advisory Committee, could be given to the students to evaluate the BIG Conference. After responses on the questionnaire have been tabulated, the results should be shared with the class. This is a good opportunity to reinforce the concept of the vital role played by the citizen participatory groups in advising governmental agencies concerning public policy.

Questionnaire for the BIG Conference

Instructions: Please fill out the following questionnaire by placing the appropriate number in front of each statement. This questionnaire will help us evaluate the impact of the BIG Conference. Please do not sign the questionnaire.

1	2	3	4	5
Strongly Agree	Somewhat Agree	Not Sure	Somewhat Disagree	Strongly Disagree

___ 1. BIG interest group members understood their roles in affecting Bay issues policy decisions.
___ 2. A good sense of cooperation and teamwork existed between your interest group and other groups at this BIG Conference.
___ 3. Delegates listened to and understood each other at this BIG Conference.
___ 4. Interest group members developed a good knowledge of the Bay-related subject matter being addressed at this BIG Conference.
___ 5. Ample opportunity was given either during or between conference activities for discussion and reflection on THE information about which decisions were made.
___ 6. Delegates were able to carry out their roles.
___ 7. Delegates were able to research concerns relevant to their roles.
___ 8. All BIG delegates had a chance to speak their minds and share their opinions during this conference.
___ 9. Your BIG interest group was able to compile a completed final report to DNR which met your expectations.
___10. BIG delegates had ample opportunity to review materials prior to each conference activity.
___11. BIG delegates were well versed on the kinds of decisions that they need to make at the conference.
___12. BIG delegates knew how their decisions would be used prior to making them at this conference.
___13. BIG activities were well designed with a sequence of meeting activities that was appropriate to the kinds of decisions that needed to be made during the conference.
___14. The BIG delegates learned how to resolve differences.
___15. In general, I liked the way BIG activities were run.
___16. The amount of time spent discussing an item at the BIG conference was appropriate to the importance of that item.
___17. The Big conference provided ample opportunities for each interest group to reach decisions together.
18. Please list additional specific suggestions for improving the BIG conference.

ACTIVITY 7

Debriefing

Purpose

1. To integrate the concepts and processes learned from the BIG Conference simulation experience.

2. To evaluate the participants' learning experiences including achievement of the BIG simulation process objectives and skills.

Materials

1. Map: "Generalized Land-Use Patterns of the Chesapeake Bay Region, 1970"

2. Map: "Projected Land-Use Patterns of the Chesapeake Bay Region, 2020"

3. Appendix I: "The Chesapeake Bay Agreement of 1983/Maryland's Chesapeake Bay Program Initiatives, 1984"

Procedure

In Activity 7 students are no longer in their assigned roles, but rather are once again students.

1. *Integration of concepts and processes.* Three suggestions are offered to encourage the integration of the concepts and processes with which the students dealt in the preceding six activities. First, students should examine the map "Projected Land-Use Patterns of the Chesapeake Bay Region, 2020," and compare it to the map "Generalized Land-Use Patterns of the Chesapeake Bay Region, 1970." Second, the students should critically analyze the formal 1983 agreement to manage the Chesapeake Bay made between the Environmental Protection Agency, the District of Columbia, and the governors of Maryland, Pennsylvania, and Virginia, particularly in terms of their understanding resulting from the BIG Conference simulation experience. Third, students should closely examine Maryland's 1984 Chesapeake Bay Program Initiatives in terms of their understanding resulting from participation in the BIG simulation.

(a) Considering the future. The "2020" land-use map of the Chesapeake Bay region should be mounted beside the "1970" map. Students should examine the colorcoded legends of the two maps and compare and contrast changes projected to occur in this 50-year period. The students should notice that for certain uses change is not projected between the two maps. For example, "shellfish production" and "anadromous spawning sites" remained the same for the two periods of time, even though both may become radically altered by 2020. "If-then" speculations should be encouraged.

Some possible directions and questions for comparing the maps are as follows:

(1) *What changes may occur to wetlands by 2020?*

The wetlands may decrease in acreage due to natural processes and human activities such as siltation resulting from commercial, recreational, development, and agricultural practices. Filling in wetlands for marinas, industry, and development may further impact the wetland areas.

(2) *What changes are projected for shellfish production by 2020? Why?*

Although no changes were projected on the "future" map, change in shellfish production by 2020 may occur. The harvest may decrease due to greater siltation, chemical pollution, excessive harvesting, and decreased wetland acreage.

(3) *What changes are projected for anadromous fish spawning areas by 2020? Why?*

No changes were projected for 2020, but siltation, chemicals, pollution, over-harvesting, decreased food sources may eliminate some species of finfish and greatly decrease the number of other species.

(4) *How may sewage treatment plants and electrical power generating plants affect the Bay by 2020?*

Sewage treatment plants and electric power facilities will change both in number and in capacity. Small, marginal sewage treatment and electric power facilities with outdated technology will be phased out, replaced by larger, more efficient, and environmentallysound facilities. For instance, in the Baltimore area, the "projected" map shows a decrease in the number of electric power plants; however, these facilities are projected to have, on the average, a much greater generating capacity. With a projected 100% increase in population, one would expect a similar increase in the capacity of both electric power and waste treatment facilities. The Three Mile Island incident, the ongoing Mid-East crisis, energy alternatives, and conservation measures will result in demands for changes which are extremely difficult to predict at this time. These variables will directly or indirectly influence energy-use patterns and the style of life of people in the year 2020. The students should thoroughly discuss these implications.

Each of these facilities will have the potential to pollute the Bay and result in harm to biological species which inhabit the Bay. The effect will be a measure of both the quantity of the effluent and the degree of toxicity.

(5) *Describe projected changes in the size and location of urban areas. Discuss factors which may contribute the projected "new" urban areas along the Chesapeake Bay.*

Existing urban areas will increase in size by 2020. The areas between Washington, D.C. and Baltimore, Maryland; Washington, D.C. and Frederick, Maryland; and Washington, D.C. and Richmond, Virginia are expected to become greatly urbanized. Consequently, highways will be improved and increased numbers of homes will be built near business areas. Many areas on the Bay are expected to become urbanized where ports are developed or expanded, with industries then locating near the ports.

(6) *Discuss possible impacts of these urban areas and their increased population on Bay ecology by the year 2020.*

Increasing amounts of pollutants will end up in the Bay from both point sources and nonpoint sources: increasing use of recreational facilities; increasing use of the Bay for transportation; increasing numbers of industrial facilities; increasing sewage disposal; more electrical generation; less harvestable food; poorer water quality; less habitat.

(7) *Locate the industrial areas on both the "present" and "future" maps. How are they expected to change? What impact will these industrial areas have upon the Bay?*

Industry is expected to increase in the urban areas and along the interstate highway systems, all near the Bay or its tributaries. Major impacts are projected in the Baltimore area and the Norfolk/Newport News area. The impacts may be severe on the life of the Bay and the overall water quality if the potentially harmful impacts are not carefully monitored and controlled. The more pollutants that end up in the Bay, the more difficult it will be for the life in the Bay to survive in this stressed environment.

(8) *How are the forest lands and agricultural acreage projected to change by 2020?*

A decrease is projected in both forests and agriculture lands. The decrease in agriculture acreage is due to a variety of factors including the rising cost of equipment and labor necessary to operate farms, and the demand for housing and other nonagricultural land uses. In addition, the amount of forest and pasture lands may increase relative to cropland because these operations are less costly than agriculture.

(9) *What can be learned from consideration of the open space, park, and conservation areas on the "projected" map?*

It is possible to see the extent that local, state, and federal governments are planning for these land uses in order to provide recreational, open space, and conservation areas for the projected increased demands due to population increases.

(10) Note the scale of the two maps. Both maps indicate the same scale, but there is actually a slight difference due to a bigger border on the 1970 map. If you choose to measure and compare areas on the two maps you may wish to correct for these differences. The ratio of distance of the 2020 map to the 1970 map is 1.05:1. The scale on the 2020 map is accurate.

(b) Both the Chesapeake Bay Agreement of 1983 and the summary of Maryland's 1984 Bay Initiatives found in Appendix I should be read by the class. A transparency of the Agreement and Initiatives may be projected and sections discussed sufficiently so as to be clearly understood. Discuss the significance in terms of what the students think might be done as a result of the Agreement and Initiatives. Specific questions might include:

(1) *What specifically did the EPA, the governors, and the District of Columbia agree upon?*

(2) *What are the responsibilities of the Chesapeake Executive Council?*

(3) Based upon what you have learned through the videotape presentation "A Question of Balance" and your participation in the BIG Conference simulation, how effective do you think the Agreement will be? (Do you think that it will help in the future management for a healthy Bay?)

A variety of speculative responses will be offered. Encourage divergent thinking.

(4) *What do you think might happen when new governors are elected as well as a new mayor in the District of Columbia?*

A variety of speculative responses will be offered. Encourage divergent thinking.

(5) *What is the* Maryland's 1984 Chesapeake Bay Initiatives Program? *What are the specific components?*

(6) *What Bay issues does the* Maryland's Bay Initiatives Program *address? Which issues are not addressed?*

(7) *Based upon what you have learned through the videotape presentation "A Question of Balance" and your participation in the BIG Conference simulation, how effective do you think the Initiatives will be? (Do you think they will help in the future management for a healthy Bay?)*

(8) *What additional initiatives and legislation, if any, will be needed to properly manage and restore the Bay?*

(9) *Based on information in the Bay Initiatives, how might you now modify the Bay policies approved by the BIG Conference?*

2. *Evaluation of the Individual's Experience*

(a) As a class discussion, ask the students to evaluate what has happened during the Activities, particularly in terms of their own experiences. Some questions for discussion are as follows:

(1) *What did you find surprising about the simulation?*

(2) *What did you like about the simulation experience? Dislike? Please elaborate.*

(3) *When were there contradictions between the "real" you and the role you were playing? Were there contradictions between your individual role and the role of your group?*

(4) *What facts have you learned about the environment of the Bay region?*

(5) *What concepts and processes concerning the Bay did you develop an understanding of?*

(6) *What have you learned about government and management in the Bay area? How could what you learned be applied to a local environmental problem?*

(7) *How can you apply these experiences to real life?*

(8) *What did you learn about yourself and your classmates which you did not know before?*

(9) What are some of the skills and attitudes one needs to work effectively in a group?

(10) *What are some of the skills and attitudes one needs to help others to appreciate your point of view?*

(11) *What did you learn that you would not have learned if this unit had been presented using a textbook and discussion rather than the game?*

Encourage students to discuss specific events that the class experienced during the game. Do not simply answer a question and move on. In-depth discussions of the processes at work in the simulation can be an important learning experience to enable students to "see the big picture." These discussions should emphasize relationships between the BIG Conference simulation and previous educational experiences. This decreases the chance that students will view their participation in this simulation as an isolated education experience; rather, they will see it as an integral part of their growing knowledge and understanding of natural, social, and political processes found in the world outside the classroom.

3. *Criterion-referenced scheme based on student objectives and skills.* The form provided below can be used by each student for self-evaluation as well as by the teacher to evaluate the student. After the form is completed by both student and teacher, the teacher should review this evaluation with the student. While this form could be used to assign a grade, it is designed primarily to be used to indicate strengths and weaknesses in a student's performance during the simulation experience.

Objectives and Skill Achievement Rating Sheet

Name:________________

1. Completed with above-average attainment or participation.
2. Completed satisfactorily.
3. Did not complete but attempted.
4. Did not attempt.

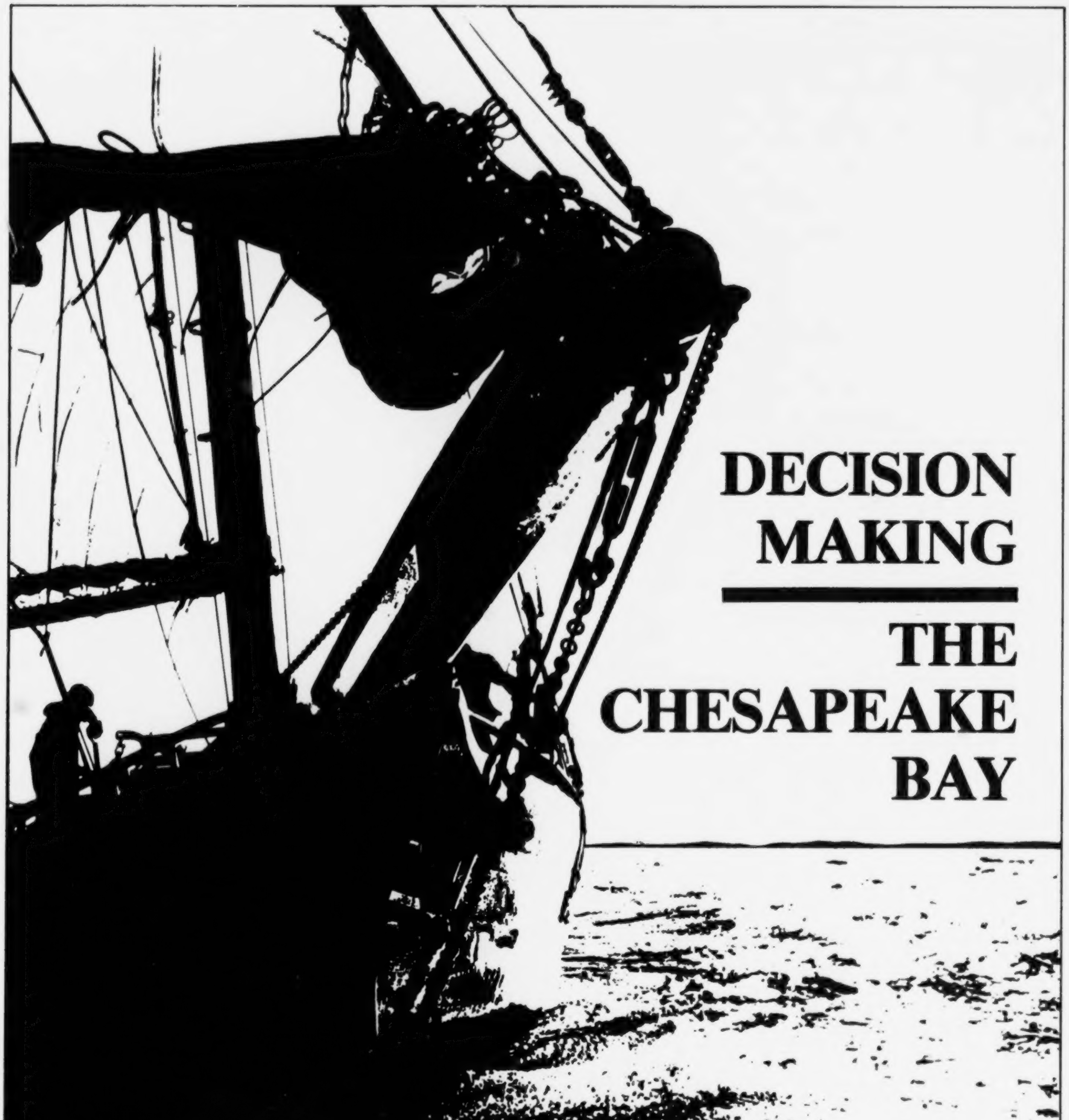
BIG Conference simulation objectives

The student demonstrated the ability to:	Student Rating	Teacher Rating
1. Identify and analyze the key economic, political, social, biological, and physical factors and interactions associated with the Chesapeake Bay and region.	_____	_____
2 Describe the competing and conflicting pattern of issues and groups around the environments and people of the Bay area.	_____	_____
3. Analyze current management policies and schemes, at the federal, state, and local levels, for maintaining a healthy Bay ecosystem.	_____	_____
4. Develop critical thinking skills for solving problems facing the Bay by participating in a problem-solving simulation where the student:		
(a) Assumed a given role and research the concerns relevant to the role.	_____	_____
(b) Met in an interest group to identify shared concerns.	_____	_____
c) Negotiated and bargained to select Bay environmental issues for further study.	_____	_____
(d) Researched, wrote, and presented policy options, one for each environmental issue selected.	_____	_____
(e) Negotiated and bargained to select policy statements for further research.	_____	_____
(f) Determined the impact of each policy option on the environments and the people of the Bay area.	_____	_____
(g) Proposed means to lessen any possible negative impact each policy option might have on the environments and the people of the Bay area.	_____	_____
(h) Prepared a defense of a selected public policy.	_____	_____
(i) Applied critical thinking and problem-solving skills to local environmental problems.	_____	_____

BIG Conference Simulation Process Skills

1. Select pertinent information from readings, maps, graphic, and audiovisual presentation.	_____	_____
2. Organize, analyze, and evaluate data in various forms.	_____	_____
3. Draw conclusions from incomplete data by supporting conclusions with additionally researched information.	_____	_____
4. Apply conclusions for the purpose of assessing issues and developing public policy.	_____	_____
5. Analyze relationships between people and issues.	_____	_____
6. Formally present a particular conclusion.	_____	_____
7. Debate conflicting issues.	_____	_____
8. Compromise when conflicting views develop.	_____	_____
9. Formally participate in group discussions.	_____	_____
10. Predict impacts of present conditions and future projections.	_____	_____

APPENDICES



APPENDIX A

Topic and Issue Cross-References: The Chesapeake Bay Data Bank

The *Chesapeake Bay Data Bank* consists of 85 pages of material that describes the Bay's environmental setting and natural resources, and the various human uses and impacts. The data bank is adapted, with permission, from the U.S. Army Corps of Engineers' *Chesapeake Bay: Future Conditions Report.*

A detailed table of contents and glossary, included with the data bank, will aid teacher and student alike in selecting Bay issues, developing Bay policy, and evaluating the potential impact of policy. It is essential that interest groups use the data bank in their selection, development, and evaluation activities.

The alphabetical glossary found at the end of the data bank is adapted from the U.S. Army Corps of Engineers' *Chesapeake Bay: Future Conditions Report, the Thorndike World Book Dictionary,* and *Our Nation's Wetlands* (the Interagency Task Force report coordinated by the Council on Environmental Quality). It is designed to enhance the understanding of terminology used in the data bank and in the activities.

Interest groups will ask the teacher for assistance in finding appropriate data. As a facilitator, the teacher should direct the students in locating and interpreting data, but it is *not* the teacher's role to give the students the specific location of pertinent information they need to develop a public policy or to support an EIS. The students should be responsible for thoroughly researching the data bank with as little assistance as necessary from the teacher.

In this Appendix, three teacher cross-references are provided for the data bank. First, there is a cross-reference of the Bay issues and interest groups by the major topics found in the table of contents ("Chesapeake Bay Data Bank Table of Contents Cross-referenced by Issues and Interest Groups").

Second, "Chesapeake Bay Data Bank Cross-Referenced to the 20 Bay Issues" identifies information pertinent to each of the 20 Bay issues.

Third, "Chesapeake Bay Data Bank Cross-Referenced by Topics" identifies a variety of relevant concepts, principles, and ideas that the student will use in selecting issues, developing policies, and evaluating the environmental impact of policies. The third cross-reference, by topics, is divided into the five categories: "biota," "land use," "navigation," "recreation," and "water quality." Within each category the topics and subtopics are listed by page number. For example, the category "biota" has several topics, one of which is "Fish & Wildlife." Under "Fish & Wildlife" are listed the subtopics "commercial," pages 63 and 64; "management," page 65; and "regulations," page 65—all of which describe pertinent information on fish and wildlife. This cross-reference is designed to aid the teacher as a "quick-key" to information in the data bank.

Chesapeake Bay Data Bank Table of Contents Cross-Referenced by Issues and Interest Groups

Section I: The Chesapeake Bay region

Geology
  Issues 7,8,10,14,15,17,18,20
  Interest groups D,E,F,G 1

Climate and hydrology
  Issues 7,8,10,14,15,17,18,20
  Interest groups D,E,F,G 1–2

Estuary
  Issues—all twenty
  Interest Groups—all seven 2–6

Biota
  Issues—all twenty
  Interest groups—all seven 6–9

Population characteristics and economic sectors
  Issues 1,2,11,12,13,14,15,16,19,20
  Interest groups—all seven 8–15

Land use
  Interest groups 2,3,4,5,6,7,8,10,11,12,
  13,14,15,16,17,18,19
  Interest groups—all seven 15–19

Section II: Water resource problems and needs

Water supply
  Issues 1,2,3,4,5,8,10,11,12,13,15,19,20
  Interest groups—all seven 19–27

Water quality
  Issues—all twenty
  Interest groups—all seven 27–35

Outdoor recreation
Issues 1,4,5,7,14,15,16,20
Interest groups A,B,C,D,E,G 36–44

Section III: Navigation, flood control, and shoreline erosion

Navigation
  Issues 1,2,3,6,12,13,19
  Interest groups A,B,C,D,F,G 44–54

Flood control
  Issues 5,7,8,14,17,19,20
  Interest groups A,B,C,D,G 55–58

Shoreline erosion
  Issues 3,5,6,7,19
  Interest groups A,C,D,F,G 55–62

Section IV: Fish & Wildlife, electric power, noxious weeds

Fish & Wildlife
Issues 1,2,3,4,5,6,7,8,9,11,15,19
Interest groups A,B,C,G 63–69
Electric power
Issues 11,13,14
Interest groups B,D,E,F,G..................70–79
Noxious weeds
Issues 1,2,4,5,15
Interest groups A,F,G 79–83

Epilogue 84–85

Key to Interest Groups

Groups	*Roles*
A. Wetlanders	
Maryland Shellfisher Association	G. Bradley
Chesapeake Commercial Finfishing Association	B. Sturgeone
Peninsula Trappers' Association	H. Adkins
Waterfowl Hunting Guides of Maryland Association	L. Churchill
Delmarva Clamming Association	J. Scott
B. Environmentalists	
Save the Bay Foundation	W. Benning
Wetland Preservation Committee	S. Crawford
Conservation Commission	D. McGowen, M.D.
Women Voters for Ecology	H. Jordan
Community action representative	B. Johnson
C. Recreationists	
Chesapeake Bay Yacht Club Association	E. Whitehead
Chesapeake Bay Sport Fisherman's Association	F. Johnson
Chesapeake Bay Game Hunters' Association	T. Swanson
Beach Owners' Association	W. Jordan
Chesapeake Bay Visitors' Association	J. Watson
D. Developers	
Chesapeake Home Builders' Association	T. Gilbert
United Realtors' Association	P. Martin
Commercial Construction Association	R. Heffner
Bankers' Association	H. Setters
Economic Consultants, Inc.	F. Lauter
E. Private Interests	
Home Owners' Association	H. Honner
Double "F" Association (Farmers and Foresters)	P. Ameri
Small Business Association	C. Zimmerman
Sand and Gravel Company	H. Shore
United Marina Owners' Association	E. Holloway
F. Industrialists	
East Coast Steel	M. Washburn
Metro Steamship Agency	W. Moskowitz
United Petroleum Interests	E. Banks
Chesapeake Bay Power Company	L. Greenburg
Harbor & Port Consultants, Inc.	E. Brown
G. Scientists	
Disaster control	W. Stanton, Ph.D.
Water quality scientist	M. Kirk, Ph.D.
Air quality scientist	M. West
Fish & Wildlife scientist	J. Richardson
Botanist	M. Miller, Ph.D.

Chesapeake Bay Data Bank Cross-Referenced to the 20 Bay Issues

1. Recreational boating and marina development

Section I
I. Environmental setting..................1
Climate 2
Surface water..................2
Chesapeake estuary..................2
Biota..................6
II. People: population characteristics..................8
III. People: economics 10
Manufacturing 10
Armed forces..................10
Construction 12
Other sectors 12
Economic and demographic projection..................13
Section II
I. Water supply 19
Current status 19
Municipal water supply 19
Industrial water supply 20
Future supply..................23
Management 26
II. Water quality..................27
Current status 27
Water quality parameters..................30
III. Outdoor recreation (entire) 36
Section III
I. Navigation..................44
IV. Shoreline erosion..................58
Section IV
I. Fish & Wildlife 63
III. Noxious weeds..................79
IV. Epilogue..................84

2. Commercial shipping

Section I
I. Environmental setting..................1
Biota..................6
II. People: Population characteristics 8
III. People: Economic sector 10
Manufacturing 10
Agriculture 12
Fisheries..................12
Construction 12
Other sectors: trade, transportation 12
Economic and demographic projection..................13
Land-use issues 15
Section II
I. Water supply 19
Current status 19

Municipal water supply ... 19
Industrial water supply ... 20
Future water quality needs ... 23
Management and other problem areas ... 26
II. Water quality ... 27
Current status ... 27
Water quality parameters ... 30

Section III

I. Navigation ... 44
II. Channel capacities ... 44
IV. Shoreline erosion ... 58

Section IV

I. Fish & Wildlife ... 63
III. Noxious weeds ... 79

3. Dredging and disposal of dredged materials

Section I

I. Environmental setting ... 1
Estuary ... 2
Biota ... 6
III. People: Economic sector ... 8
Public administration ... 11
Other sectors: trade, transportation ... 12
Economic and demographic projections ... 13

Section II

I. Water supply ... 19
Municipal ... 19
Industrial ... 19
Management and other problem areas ... 25
II. Water quality ... 27
Current status ... 27
Water quality parameters ... 30
Existing and future conditions ... 31

Section III

I. Navigation ... 44
II. Future supply ... 46
III. Flood control ... 55
IV. Shoreline erosion ... 58

Section IV

I. Fish & Wildlife ... 63
III. Noxious weeds ... 79

4. Harvesting living aquatic resources

Section I

I. Environmental setting ... 1
Estuary ... 2
Biota ... 6
III. People: Economic sector ... 8
Manufacturing ... 10
Agriculture ... 12
FIsheries ... 12
Other sectors: trade, communication ... 12

Section II

I. Water supply ... 19
Current status ... 19
Future water supply ... 23
Management ... 25
II. Water quality ... 31
Current status ... 31
Water quality parameters ... 33
Existing water quality conditions ... 34
III. Outdoor recreation ... 36

Section III

No information in this section.

Section IV

I. Fish & Wildlife ... 63
III. Noxious weeds ... 79

5. Tidal and nontidal wetlands

Section I

I. Environmental setting ... 1
Biota ... 6
III. People: Economic sector ... 8
Public administration ... 11
Agriculture ... 12
Fisheries ... 12
Construction ... 12
Land use ... 15

Section II

I. Water supply ... 19
Current status ... 19
Management and other problem areas ... 17
II. Water quality ... 27
Current status ... 27
Water quality parameters ... 30
Existing water quality conditions ... 30
III. Outdoor recreation ... 36

Section III

III. Flood control ... 55
IV. Shoreline erosion ... 58

Section IV

I. Fish & Wildlife ... 63
III. Noxious weeds ... 79

6. Shore erosion

Section I

I. Environmental setting ... 1
Biota ... 6
III. People: Economic sector ... 8
Public administrtion ... 11
Agriculture ... 12
Fisheries ... 12
Construction ... 12
Other sectors: transportation ... 12
Economic and demographic projections ... 13
Land use ... 15

Section II

I. Water supply—natural stream flow ... 19
Management and other problems ... 22
II. Water quality ... 27
Current status ... 27
Water quality parameters ... 30
Existing water quality conditions ... 30

Section III

I. Navigation ... 44
II. Future supply ... 46
III. Flood control ... 55
IV. Shoreline erosion ... 58

Section IV

I. Fish & Wildlife ... 63

7. Use of flood plains

Section I
I. Environmental setting ... 1
  Geology ... 2
  Ground water hydrology ... 2
  Chesapeake Bay estuary ... 2
  Biota ... 6
III. People: Economic sector ... 8
  Public administration ... 12
  Agriculture ... 12
  Construction ... 12
  Other sectors: finance, insurance ... 12
  Economic and demographic projections ... 13
  Land use ... 15
Section II
I. Water supply: impoundments ... 19
  Management and other problems ... 22
II. Water quality ... 27
  Current status ... 27
  Water quality parameters ... 30
  Existing conditions by area ... 31
Section III
III. Flood control ... 55
IV. Shoreline erosion ... 58
Section IV
I. Fish & Wildlife ... 63

8. Use of agricultural lands

Section I
I. Environmental setting ... 1
  Geology ... 1
  Climate ... 1
  Surface water hydrology ... 2
  Ground water resources ... 2
  Biota ... 6
III. People: Economic sector ... 8
  Manufacturing ... 10
  Agriculture ... 12
  Fisheries ... 12
  Construction ... 12
  Other sectors: transportation, finance ... 12
  Land use ... 15
Section II
I. Water supply ... 19
  Current status ... 19
  Rural water use ... 20
  Management ... 22
II. Water quality ... 27
  Current status ... 27
  Water quality parameters ... 30
  Existing conditions by area ... 30
Section III
IV. Shoreline erosion ... 58
Section IV
I. Fish & Wildlife ... 63

9. Beach access

Section I
I. Environmental setting ... 1
  Biota ... 6
III. People: Economic sector ... 8
  Public administration ... 11
  Armed forces ... 12
  Construction ... 12
  Economic and demographic projections ... 13
  Land use ... 15
Section II
I. Water supply ... 19
  Management of water supply ... 22
II. Water quality ... 27
  Current status ... 27
III. Outdoor recreation ... 36
Section III
IV. Shoreline erosion ... 58
Section IV
I. Fish & Wildlife ... 63

10. On-shore oil and natural gas facilities

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I. Environmental setting ... 1
  Biota ... 6
III. People: economic sector ... 10
  Public administration ... 11
  Armed forces ... 12
  Construction ... 12
  Economic and demographic projections ... 13
  Land use ... 15
Section II
II. Water quality ... 27
  Current status ... 27
Section III
No information in this section.
Section IV
No information in this section.

11. Electric generating facilities

Section I
I. Environmental setting ... 1
  Estuary ... 2
  Biota ... 6
II. People: Population ... 8
III. People: Economic sector ... 10
  Manufacturing ... 10
  Public administration ... 12
  Construction ... 12
  Other sectors: public utilities ... 12
  Economic and demographic projection ... 13
Section II
II. Water quality ... 27
  Current status ... 27
Section III
No information in this section.
Section IV
I. Fish & Wildlife ... 63
II. Electric power ... 70
IV. Epilogue ... 84

12. Ports

Section I
I. Envrionmental setting 1
Estuary 2
Biota 6
II. People: Population 8
III. People: Economic sector 10
Manufacturing 10
Public administration 11
Fisheries 12
Armed forces 12
Construction 12
Other sectors 12
Economic and demographic projections 13
Section II
I. Water supply 19
Current status 19
Municipal 19
Industrial 19
Management 22
II. Water quality 27
Current status 27
Parameters 30
Section III
I. Navigation 44
II. Future supply 46
Section IV
No information in this section.

13. Industrial parks

Section I
I. Environmental setting 1
Estuary 2
Biota 6
II. People: Population 8
III. People: Economic sector 10
Manufacturing 10
Construction 12
Other sectors: trade 12
Economic and demographic projection 13
Land use 15
Section II
I. Water supply 19
Current status 19
Municipal 19
Industrial 19
Management 22
II. Water quality 27
Current status 27
Parameters 30
Existing and future 30
Section III
I. Navigation 44
II. Future supply 46
Section IV
II. Electric power 70

14. Residential development

Section I
I. Environmental setting 1
Geology 1
Climate, hydrology 2
Estuary 2
Biota 6
II. People: Population 8
III. People: Economic sector 10
Manufacturing 10
Fisheries 12
Armed forces 12
Construction 12
Other sectors 12
Economic and demographic projection 13
Land use 15
Section II
I. Water supply 19
Current status 19
Municipal 19
Future 23
Management 25
II. Water quality 27
Current status 27
Parameters 30
Existing conditions by area 31
III. Outdoor recreation 36
Section III
IV. Shoreline erosion 58
Section IV
II. Electric power 70

15. Sewage-treatment facilities

Section I
I. Environmental setting 1
Geology 1
Hydrology 2
Biota 6
II. People: Population 8
III. People: Economic sector 10
Manufacturing 10
Public administration 11
Fisheries 12
Armed forces 12
Construction 12
Other sectors: public utilities, real estate 12
Land use 15
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I. Water supply 19
Current status 19
Municipal 19
Future 23
Management 27
II. Water quality 27
Current status 27
Parameters 30
Existing conditions by area 31
III. Outdoor recreation 36
Section III
IV. Shoreline erosion 58
Section IV
I. Fish & Wildlife 63
III. Noxious weeds 79

16. Land transportation facilities

Section I
- II. People: Population 8
- III. People: Economic sector 10
  - Agriculture 12
  - Armed forces 12
  - Construction 12
  - Other sectors: trade, transportation 12

Section II
- III. Outdoor recreation 36

Section II

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Section IV

No information in this section.

17. Forested lands

Section I
- I. Environmental setting 1
  - Geology 1
  - Climate, hydrology 1
  - Biota 6
- III. People: Economic sector 10
  - Agriculture 12
  - Fisheries 12
  - Economic and demographic projections 13
  - Land use 15

Section II
- I. Water supply 15
  - Rural 20

Section III

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Section IV

No information in this section.

18. Mineral extraction (sand and gravel)

Section I
- I. Environmental setting 1
  - Geology 1
  - Biota 6
- III. People: Economic sector 10
  - Manufacturing 10
  - Fisheries 12
  - Other sectors 12
  - Land use 15

Section II
- II. Water quality 27
  - Current status 27
  - Parameters 30

Section III
- I. Navigation 44
- II. Future supply 52
- IV. Shoreline erosion 58

Section IV

No information in this section.

19. Channelization

Section I
- I. Environmental setting 1
  - Estuary 2
  - Biota 6
- II. People: Population 8
- III. People: Economic sector 10
  - Manufacturing 10
  - Public administration 11
  - Fisheries 12
  - Other sectors 12
  - Economic and demographic projections 13

Section II
- I. Water supply 19
  - Municipal 19
  - Industrial 19
- II. Water quality 27
  - Current status 27
  - Parameters 30

Section III
- I. Navigation 44
- II. Future supply 52
- III. Flood control 55
- IV. Shoreline erosion 58

Section IV
- I. Fish & Wildlife 63

20. Recreation, open space, and natural areas

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- I. Environmental setting 1
  - Geology 1
  - Estuary 2
  - Biota 6
- II. People: Population 8
- III. People: Economic sector 10
  - Public administration 11
  - Fisheries 12
  - Armed forces 12
  - Other sectors 12
  - Economic and demographic projections 13
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Section II
- I. Water supply 19
  - Current 19
  - Rural 20
  - Management 22
- II. Water quality 27
  - Parameters 30
- III. Outdoor recreation 36

Section III

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- I. Fish & Wildlife 63

Chesapeake Bay Data Bank Cross-Referenced by Topics

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Economics
- Agriculture 12,15
- Fisheries 12
- Wildlife management 65

Environmental setting
- Consumers 6–8

  - Plant-Animal organisms ... 9
  - Producers ... 6
- **Fish & Wildlife**
  - Commercial ... 63,65
  - Management ... 65
  - Problems ... 65
  - Recreational ... 64
  - Regulations ... 65
- **Navigation**
  - Disposal ... 44,45
  - Oil ... 54
  - Transportation ... 66,68
- **Noxious weeds**
  - Control measures ... 81
  - Types ... 80
- **Sedimentation**
  - Agriculture ... 15,18,34
  - Development ... 34,35
  - Shoreline erosion ... 58,61,62
  - Tidal flooding ... 55
  - Water quality ... 30,34
- **Water supply**
  - Bay ... 2,3,4
  - Groundwater ... 1,2,25,27
  - Surface water ... 1,2,25,27
  - Tributaries ... 49-51
- **Water quality**
  - Bacteria ... 30
  - Biochemical Oxygen Demand ... 30
  - Control ... 35
  - Oil ... 34,46
  - Parameters ... 30
  - Sewage ... 30,34,35
  - Thermal ... 72,76

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- **Agriculture**
  - Biota ... 6,7,8,65,67
  - Economic ... 12
  - Existing ... 15
  - Future ... 17
  - Herbicides ... 33,35
  - Hunting ... 64,67
  - Irrigation ... 22
  - Runoff ... 33
  - Sedimentation ... 34,35
  - Water quality ... 28,30,33,34,35
  - Water supply ... 14,19,21,22,27
  - Wildlife ... 65,67
- **Development**
  - Biota ... 6-8,65
  - Construction ... 12,67
  - Domestic water supply ... 19,23,24
  - Economics ... 12
  - Marinas ... 36,37,54
  - Sedimentation ... 30,34
  - Waste disposal ... 34,35
  - Water quality ... 30
  - Waterfront lands ... 45
- **Electric power** ... 78
- **Forest**
  - Existing ... 15
  - Future ... 17
  - Sedimentation ... 30,34
  - Recreation ... 40
  - Wildlife ... 63,67
- **Industrial**
  - Biota ... 6-8
  - Controls ... 18
  - Economics ... 10,12,13,15
  - Water supply ... 20,23
  - Water quality ... 28,30,33
- **Recreation**
  - Biota ... 6-8
  - Camping ... 40
  - Economics ... 13
  - Existing ... 36
  - Future ... 41
  - Picnic ... 39
  - Regulation ... 61
  - Water quality ... 31,34
  - Wildlife ... 66-69
- **Wetlands**
  - Biota ... 6-8
  - Dredge disposal ... 44,52
  - Electric power ... 78
  - Estuary ... 6
  - Shoreline erosion ... 58,62
  - Wastewater ... 35
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- **Biota**
  - Habitat ... 67
  - Harvest ... 63,65,68
  - Regulation ... 65
- **Economics**
  - Economic projections ... 13
  - Trade ... 1
  - Transportation ... 12
- **Environmental setting**
  - Bay depth ... 2
  - Bay size ... 2
  - Tidal currents ... 2
- **Erosion**
  - Shoreline erosion ... 45,54,58,62
- **Ports**
  - Navigation ... 44,52,54
  - Trade ... 52,54
- **Recreation**
  - Boating ... 37
  - Swimming ... 37
- **Water quality**
  - Existing ... 30,31
  - Future ... 33,34
  - Oil ... 34
  - Management ... 35
  - Sedimentation ... 44,52

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  Fish 7
  Mammals 8
  Waterfowl 7
Fish & Wildlife
  Federal regulations 65
  Means to satisfy needs 68
  Nonconsumptive utilization 65,68
  Sportfishing and hunting 64,66,67
Navigation
  Alleviate congestion 54
  Expand ports, marinas 54
  Minimize accidental oil spills 54
  Minimize conflicts 54
  Shoreline erosion 45
Outdoor recreation 36–43
Shoreline erosion
  Existing problems 59
  Regulatory actions 61
Water quality
  Oil and marine transportation 34
  Recreation activities 34

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Climate and hydrology
  Groundwater 2
  Precipitation 1
  Surface water 1
Electric power
  Cooling water requirements 72,76
  Water use 78
Estuary
  Nutrients 6
  Physical factors 4
  Salinity currents 4
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  Agriculture 15,17
  Controls 18
  Forest 15,17
  Urban 15,17
  Wetlands 15,17
Navigation
  Dredging 44,52
  Oil spills 54
Recreation
  Problems 36
  Solutions 42
Sedimentation
  Agriculture 17
  Development 12,30,34,76
  Forests 17
  Navigation 41
  Shoreline erosion 45
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Wildlife
  Conflicts and problems 65,67
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APPENDIX B

The Chesapeake Bay: What It Is to You (Slide-Tape Script)

Part I

Numbers between asterisks (*1*) indicate slide change and the slide number.

1 General Title *2* Part 1 Title *3* The Chesapeake Bay is a large body of water shared by Maryland and Virginia and is America's largest estuary.

4 People use the Chesapeake Bay as a source of jobs and food. . . *5* Transportation and industry. . . *6* Water supply and waste disposal. . . *7* Recreation and housing. . . *8* Forestry and agriculture. *9* The Chesapeake Bay is the most valuable estuary in North America. It is vital that this resource be properly managed, now and in the future.

10 The Chesapeake Bay must be protected from becoming heavily polluted as was experienced with both the San Francisco Bay and Lake Erie.

11 The Chesapeake Bay is an estuary, a semienclosed body of water where rivers meet the ocean. Over ninety percent of the Chesapeake Bay's fresh water comes from ten major river systems shown here. Of these the northernmost river, the Susquehanna, alone contributes over 50% of the fresh water. *12* The Chesapeake is a partially-mixed estuary with the denser saline water from the Atlantic Ocean flowing up the Bay on the bottom, While the lighter fresh water flows down the Bay near the surface. Mixing of the saline and fresh water occurs where these layers meet.

13 When it rains, the water that is not absorbed by the earth or evaporated, collects in small rivulets which merge into streams. *14* These streams flow into rivers and the rivers into the Bay. *15* The Chesapeake Bay drains a watershed of about 64,000 square miles. *16* The watershed area includes Washington, D.C., and parts of the states of Delaware, Maryland, New York, Pennsylania, West Virginia and Virginia.

17 Chesapeake Bay waters provide the nutrients required for life in the Bay's ecosystem including 600,000 acres of marshes. *18* The Chesapeake Bay is about 200 miles long and has over 7,000 miles of coast line, with a surface area of 4,400 square miles. *19* The Bay is shallow body of water with an average depth of twenty-eight feet, and varies from four miles across at the Bay Bridge to thirty miles across at the mouth of the Potomac River.

20 The Chesapeake Bay, as shown here in the satellite image, was formed about ten thousand years ago, when melting of glaciers from the last ice age caused sea level to rise approximately 410 feet, flooding the Susquehanna River Valley. *21* The flooded river is today the Chesapeake Bay. *22* The Bay estuarine ecosystem is the interaction of both living and non-living components.

23 The life cycles of some plants and animals occur entirely in this ecosystem while other species spend only a portion of their lives in the estuary. *24* For example, the female blue crab spends her entire life in the estuary, mating in the upper Bay and spawning in the higher salinity waters of the lower Bay.

25 In contrast many species of fin fish such as the menhaden use the estuary as a nursery but spend their adult lives in the Atlantic Ocean.

26 Marsh plants grow in abundance due to rich inputs of nutrients from river and ocean sources brought twice daily by the tides. *27* For example, some marshes produce per acre as great as four times the biomass or plant matter that grows in corn fields and six times that which grows in wheat fields. *28* Submerged plants grow in the Bay, as much of the nutrient-laden water is shallow and admits a wealth of sunlight to the plants.

29 When plants die, they are decomposed by bacteria to form detritus (the gooey black materials found in the marsh). Detritus represents two links of a food chain as it includes both producers (plants) and consumers (bacteria). *30* Another food chain begins with algae or phytoplankton, microscopic plants. These producers are a source of food for many consumers. Diatoms shown here are an example of phytoplankton. *31* Zooplankton are microscopic consumers. These small animals feed on the phytoplankton and detritus in the water. This copepod is an example of zooplankton.

32 Phytoplankton and zooplankton are consumed by larger bay organisms such as oysters and small fish. *33* These species then serve as food for even larger fish, reptiles, birds, and mammals including man. The food chains just outlined and many others interact to form complex food webs.

34 In the Chesapeake Bay food web, the sun's energy is stored by phytoplankton and other plants. These producers are eaten by birds, fin fish, and shellfish. These animals in turn are eaten by predators such as fishhawks and humans. The complex interactions maintain balance on the Bay and surrounding marshes of the ecosystem.

35 In conclusion, the Chesapeake Bay is a finely-tuned ecosystem which balances the components of air, land, water, and life. *36* Any impact to one component may seriously alter the entire system. One of the oldest problems is erosion from both shore and inland areas. *37* The white sticks shown here mark the extent of shore lost by erosion over a ten-year period on one part of a marsh in the Chesapeake Bay. *38* Soil washes into the Bay from these sources, clouding the water. This clouding limits the sunlight available to plants for photosynthesis and growth. *39* The soil settles in the process of siltation and can smother the plants, shellfish, and other aquatic life found on the bottom of the Bay. *40* Erosion and siltation occur naturally; however, certain agricultural and development practices, for example, home construction, have greatly accelerated this natural process. *41* The long-term consequence of siltation is seen at Jug Bay on the Patuxent River. Today, the water is so shallow that only small boats can navigate the river, where in past times Jug Bay was a port of call for ocean-going vessels.

42 By-products of human activities, such as sewage, air pollution, toxic waste and oil spills are more recent problems for the Bay. These factors may have contributed to many of the disturbances which have been detected in the Bay ecosystem. *43* These by-products of human activity, foreign to the natural environment, can enter into food chains and potentially threaten many species of life. *44* In addition to pollutants being released directly into the Bay, tributary waters can carry substances, such as mine wastes, from great distances.

45 So far, the Chesapeake Bay remains relatively healthy because its waters have been able to scatter or break down many of the pollutants. But to maintain the continued health of this great ecosystem, both on-going research programs and management strategies have been established. *46* People's desire to live in a high-quality environment has resulted in pollution-control laws enacted to regulate sediment, erosion, water quality, recreation, construction, industry, and other activities which affect the Bay ecosystem. *47* Research efforts strive to determine the long-term effects of human activities on the Bay. Continual monitoring is necessary in order to protect the Chesapeake Bay as a natural resource for our use in the future. *48* Parents/Child/Future *49* Sunset on the Chesapeake Bay *50* Produced by *51* Music by Narrative by *52* Credits

Part II

•1• Music. •2• Music. •3• Part I of this presentation described the Chesapeake Bay and its natural history. •4• Food chains and food webs and their importance were highlighted. Interactions between organisms and their physical environment together maintain the balance of life within the Bay ecosystem. •5• Problems of the Bay, such as erosion and toxic wastes, were also noted. •6• Pollution of the ecosystem was described as well as the need to better manage the Bay.

•7• We will now explore some of the ways people benefit from the Bay. •8• The Chesapeake Bay is a major source of seafood with species such as oysters and crabs occurring in great abundance. •9• This harvest provides a livelihood for almost 25,000 watermen who supply their catch to over 200 processing plants. •10• These in turn provide many additional jobs. •11• In a recent year, the Bay's seafood harvest was worth $34 million wholesale. Processors paid watermen $16 million for oysters, $7 million for crabs, $6 million for clams, and $5 million for finfish.

•12• In addition to food and jobs, the Chesapeake Bay region provides a place for relaxation and recreation. People camp, boat, hunt, waterski, hike, picnic, and swim in and around the Bay. •13• There are over 120,000 pleasure boats registered in Maryland. The Chesapeake Bay is said to provide some of the best sailing in the world. •14• At least one regatta or sailboat race is held each week on the average. •15• Other boaters prefer power craft ranging from motorized dingys to ocean going yachts.

•16• Fishing is another important recreational activity. During a typical summer weekend nearly 100,000 people fish for sport in the Chesapeake Bay. •17• Each winter millions of Canada Geese and ducks make this region home. •18• As these early morning hunters have discovered, the abundant waterfowl that "winter" in this area provide some of the finest hunting along the Atlantic seaboard. Mammals that are favorite targets for hunters include rabbit and deer. •19• Nutria, muskrat and beaver are trapped for their fur. These pelts make up the second largest fur industry in the nation.

•20• The Bay has two outlets to the ocean, one through the Chesapeake and Delaware Canal, and the other through the natural opening at the Virginia Capes. •21• The Bay has been used by commercial vessels since 1607 when European colonists traded with their homelands. •22• Today, several thousand ships carry over 50 million tons of cargo into and out of Maryland ports each year. •23• This tonnage directly •24• or indirectly provides one out of every 10 jobs in Maryland. •25• On a tonnage basis, the waterborne commerce associated with these jobs is dominated by the transport of bulk cargo. Bulk oil, coal, ore and grain account for about three-quarters of the total tonnage passing through Maryland ports. •26• General cargo, though a much smaller percentage of the total tonnage, is also very important to Maryland because of its much higher value per ton.

•27• Other jobs include the production of finished goods for the market such as food products and machinery, •28• textiles, and ship building.

•29• Maryland owes its important position in the United States economy to its location on the Chesapeake Bay, being near both Eastern and Midwestern markets and sources of supply of raw materials. •30• Recent activities include the importation of automobiles and the development of private and public container facilities such as Dundalk Marine Terminal. •31• The movement of products to and from inland markets is accomplished through a network of railroads and highways, which provide additional jobs for the people of Maryland.

•32• Other activities can indirectly affect the water quality of the Bay. Some of these are agriculture, •33• mining, •34• forestry, •35• and land development. •36• These human activities, if not properly managed, will release materials such as pesticides, fertilizers, toxic metals, acids, and sediments which can enter or interfere with food chains •37• and threaten species of life.

•38• Researchers at the University of Maryland's Chesapeake Biological and Horn Point Laboratories are devoted to studying the biology of the Bay. •39• The Chesapeake Bay Foundation provides opportunities for citizens to participate in a variety of Bay research activities in the open bay waters, its tributaries, and in bay marshes.

•40• Citizens of the Bay region must strive to preserve the balance between what the ecosystem needs, and what they want. •41• With careful management, the Chesapeake Bay can maintain its great value as a natural resource for future generations. •42• What the Chesapeake Bay will be in the future will result from how we manage it today. The final decision is up to all of us.

•43• Music. •44• Music. •45• Music.

APPENDIX C

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APPENDIX D

A Question of Balance (Videotape script)

BILL BURTON

The one thing we've got to live with is the environment. It's most important of all. It's there and we've got to save it. There are other important things, very important things, like the economy and just fun. But the environment—absolutely important. People have got to say "Enough is enough"—they've got to say it and they've got to be militant about it.

ART SHERWOOD

You can have a commerce and you can have an orderly management of the environment, you can have a fine environment. It takes a tremendous amount of cooperation. It takes battles at times. It takes being mad. It takes being sorry.

FRANK HAMONS

It's frustrating because you deal with more than the Bay. You deal with people. You deal with people's problems, you deal with society and society's problems. You cannot be ever as effective as you'd like to be and the obvious solution or answer to your problems is never attainable.

ARLENE BAYBUTT

Too many times laws are enacted or written because of an emotional situation. Something —a tragedy happens—so right away we have to have a law to prevent it. And that law probably is causing ten tragedies because of the one. And this is where I think we need to have much more concern shown in our legislative processes.

LARRY SIMNS

Take a real dim view when anybody opposes things just for the sake of opposing. Because we know we're going to have more population, we know progress has got to keep going. We just can't say—they're not going to do this or not going to have it.

RITA COLWELL

I think the largest, our most serious problem, is the multi-demand and the increasing demand on the Bay. No one segment of users really is entitled to the entire Bay. We all have to live with it. People want to develop the Bay for housing—for the increasing population. People want to preserve the Bay for fishing, and aesthetic beauty and for recreation. People want to transport materials up the Bay. It's cheap—for fuel, for food, all the staples of life that we need, and people want to enjoy the Bay. People want to fish the Bay. So all these are legitimate users and demands and our biggest problem is balancing those demands.

NARRATOR

The Chesapeake Bay is nearly 200 miles long and has a coastline of over 7,000 miles. There are over 2700 different species of animals and a yearly harvest of finfish and shellfish yielding about $50 million at the dock. By the year 2020 the population in the Chesapeake Bay region will more than double. Water consumption is expected to increase by 800% and industry will need twice as much land. What problems will this create for the Chesapeake Bay region and how can we balance the many demands placed on its resources? This presentation focuses on the people who affect the Bay and the various points of view that they represent. The central problem is that we have a limited resource and a lot of people wanting to use it for a lot of different purposes. It's a question of balance.

FRANK HAMONS

I used an analogy once. Having some very nice homes on one side of a river. People who have perhaps been successful in life and have accomplished what all of us dream about, owning a waterfront home in a very nice neighborhood. Whereas on the other side of the river you may have a neighborhood where there are many people below the poverty level. Into this setting you bring a factory and jobs. To show you that the questions are not always easy, the factory's going to affect water quality, probably, and we have to determine how we can allow that effect to occur. If we can allow it, to what degree. You know, if I were living on the other side with my nice home, I would not want the water quality affected at all. That's why I bought that home. If I were on the opposite side of the river, needing a job to feed my family, I would want the factory at all costs. Both are very legitimate concerns. That's—what do you do in a case like that? You usually compromise.

ART SHERWOOD

The Bay, as I'm sure many of these listeners know, is the most productive estuarine system in the United States. Fantastic harvests of crab and oysters and fish—a very, very valuable resource for the world. Well, all of that means that people are competing for it and so as far as the Foundation is concerned, we have on the one hand, let's say, the need for a Bethlehem Steel plant. Bethlehem Steel is a fantastic employer. Thousands of people make their living there and a very, very important product comes out from it. But in the process, needless to say, of supplying that need of the human being—steel, good, hard, durable, usable steel—in the process of getting that out the Bay is being polluted. So the Foundation's role is to see, as much as possible, as much as we're able to, that in the process of making that steel a minimum amount of pollution is allowed to go into the Bay.

JAY THORPE

Since 1971 Bethlehem Steel has spent $62 million on water pollution abatement equipment. Pollution discharges have been reduced by at least 85%. It should be pointed out that Bethlehem is presently spending approximately 25% of its appropriated capital funds for environmental controls. We want to see the Bay flourish from an industrial, recreational, economic and environmental standpoint. However, we believe this has to be done realistically using a balanced approach to Bay management that takes into account socio-economic factors as well as environmental factors.

NARRATOR

Socio-economic factors. Social factors deal with how people would ideally like to live. Low crime rate, clean air, good relations with neighbors. Economic factors are concerned with the question "Do we have enough money to accomplish what we would like to do?" Social and economic factors must be considered together. To have a clean, healthy environment, are we willing to pay the cost of keeping it clean and healthy? Industrial influence on the Bay is one socio-economic factor. Can we provide jobs and enough money for people to live comfortably as well as keep the environment safe at the same time? Another factor deals with the Bay's fish population. People fish for both pleasure and business—for both social and economic reasons.

ARLENE BAYBUTT

The seafood industry, which was a major industry here, has been decreasing over the years because of many factors—the decrease in the quantity and quality of the oysters, clams, finfish.

FRANK HAMONS

The one thing, one point that should be made here though, is that we are probably the most—many if not most—species pass the point of abundance where we can simply look at a species for exploitation without moderating in some way those who are exploiting it. That means that there might have been a time when the recreational fisherman and the commercial fisherman could have gone out and caught rockfish without having more than perhaps a physical interference with each other occasionally because there were so many rockfish. Times such as these are—may well be—past for most species.

BILL BURTON

The sportsfisherman is lost in much of this. His apathy, he's going to have to be. He's constantly told he's not fishing for a living. You know, the commercial lobby, the commercial fishing interests, they've got tenfold, tenfold power over the legislature. They're organized. They put up the money. They put up the time. They've got to—it's their livelihood and they're effective.

LARRY SIMNS

The newspapers and sportswriters paint us as the villains of the Chesapeake Bay. We're the commercial fishermen, the big Bay commercial fishermen. We're catching all the striped bass and the sportsfishermen can't catch any. And this is really not true and the news media has really done us a disservice in this. What we see ourselves as—we catch fish to feed people that aren't able to have a small boat and go out and catch their own. We put fish on the table to the poor people, people that aren't well-off enough to go out there and spend the money to catch one or two fish. So we feel as though we're doing a big service to the state and the country. We send fish all over the state. We've been painted a picture as catching all the fish or trying to catch the last fish that swims, which is really not so because if we did then we'd be out of a job. So we have to really be more concerned about the fish than the sportsfishermen do.

BILL BURTON

Maybe we are sportsfishing. We are just fishing for sport but we're also fishing to live. We're fishing to relax. You have to get away—just got to get away from things. I don't care how old anyone is or how young they are. They've got to get away from stresses—stresses of the office, the job, the family—just everyday life stresses. Got to get out and relax, fish, swim, walk as such—a lot that's tied in with the environment. Today I think I'm as, well, I'm as informed as the average layman at least. But things are so complicated—darn complicated. Calvert Cliffs, for instance. We know fish are declining there. Now, I remember Calvert Cliffs, I remember when they started and I'm so damn mad at myself, I didn't get out and picket. I just didn't try to stop it. I let myself down; I let a lot of other people down. Calvert Cliffs was pushed on us and now we see the results. We know the waters are warm and we know we're killing fish.

ROBERT DAVIES

Have to provide electricity to our customers to keep our activity going, to encourage economic growth in the area, and this does require new power plants to be built. Our interest in the Bay is the fact that a steam electric power plant requires cooling water and we do put power plants on tributaries to the Bay and on the Bay itself. In the case of Calvert Cliffs, where we're standing, we're on the Bay. Power plants of this type use once-through cooling systems. This means that the water is pumped through the Bay, heated slightly and then discharged. And our whole effort in trying to use the Bay is to use it properly and economically so that we can maintain low-cost electricity and reliable electricity for all of our customers. The ecological studies and the marine biological studies in the Bay itself have shown that we are operating the plant without damage. The organized apposition to Calvert Cliffs from the marine-biological point of view is pretty much abated now. There doesn't seem to be much concern—the proof of the pudding is in the operation. The plant has operated successfully. The Department of Natural Resources in the state has come out very strongly that the plant is not causing damage to the Bay and this has allayed the fears pretty much to this time.

NARRATOR

The seafood industry, sportsfishing, and the power company, each using the Bay but stressing the need for balancing. We need seafood as a source of food, sportsfishing for recreation and the power company as a source of electricity. We must balance the need for relaxation and comfort with the need for food and energy. To achieve this balance, we have to be able to look at an issue from all sides, not only from our special private interest. We may have to put aside our differences. With the population in the Bay region expected to increase greatly, a critical problem arises. How do we dispose of waste or sewage? Presently a large amount of waste disposal ends up in the Chesapeake Bay.

RITA COLWELL

I really do believe as a microbiologist there are better ways of handling wastes than dumping them in the Bay, however. And I feel very strongly about that. I think we can develop recycling systems using micro-organisms—and then what we dump into the Bay is really rather clean water. I think we can develop systems —you see, new technology—and right now the technology for sewage effluent is old technology developed in the 20s and 30s—not very new.

LARRY SIMNS

The trouble with sewage treatment plants—everybody ten years ago said, "We've got to treat all this sewage and then we'll save the Bay." Well, in trying to save the Bay now we're making the Bay sterile. What they treat the sewage with is chlorine. Now chlorine is very detrimental to any form of animal life that's in the small stage when it first hatches—larvae for the oysters and small fish fry when they're first born. They can't live and survive with any amount of chlorine in the water. So we're concentrating all the water that a municipality is using in one area. We fill it full of foreign substances such as chlorine and then we're dumping it overboard.

RITA COLWELL

You see, it is expensive to do but you reach a point where it's more expensive not to and I think we're reaching that point. It's more expensive to dump it in the Bay because the problems it creates in the Bay —cleaning-up problems—than it is to really sit down and think out new processes and new techniques and develop new methods.

NARRATOR

Are you as a citizen willing to pay a large amount of money for something that will save money in the long run? Developing a system to handle the complex management of the Bay can be a difficult problem. Who should decide where and when you can fish or how much a dozen steamed crabs should cost or where a nuclear power plant should be built? Who should make those decisions?

ARLENE BAYBUTT

Most of the people here are a little bit distressed about this because we feel there are so many studies being done on the Bay and really nobody knows who's doing what. Every day we hear of a new study and there's so much federal money and state money being put into these studies that we feel that if all of the studies were put under some type of—not a control, but at least that we know of an identification of these—that perhaps some money would be better spent, better used and there would be less duplication of effort and duplication of funding. It can't be done locally—the Bay involves too many local governments and too many local groups. It can't even be done statewide because there are several states involved. So I would say that it would have to be on a federal level.

ART SHERWOOD

Eliminate all artificial, political boundaries that divide the single ecosystem of the Bay. That's the first one—there would be no division between Maryland and Virginia as far as handling or managing the resources of the Bay. That's a terribly disruptive and difficult thing to have to handle. The Virginia interests say "Yes, we ought to be able to go and dredge up in the middle of the winter the hibernating female crabs." And yet Marylanders feel that that's a terrible misuse of the resource. And yet then Virginia will look at us and say "Oh, but look, you're taking the blue crab while they're breeding—the doublers and what-have-you." And we are, we're taking the breeding stock. And that's something that shouldn't be managed that way. And the same thing with all of the coast of this great eight or ten thousand miles of shoreline. I mean it shouldn't be cut up into county jurisdictions and state jurisdictions as far as its natural resources are concerned. I'm not talking, of course, about school districts and what-have-you, but as far as the natural resources. No, the gods that made us didn't say "Make that Maryland and make this Virginia or make this Cecil County or make that Calvert County." And that kind of political division has made life difficult for us. So if I were a lord of the universe, I would swipe aside all of those political boundaries and manage the resource as one ecological unit—one ecosystem—which of course it is.

FRANK HAMONS

We don't do this now but you must eventually manage the whole resource as a whole resource if we're going to do it properly in the end. However, the state has very specific interests which are keyed to the state's citizens who live on the shores of the Chesapeake Bay, and its other natural resources. We're very directly approachable by its citizens and we're responsive to its immediate needs. In point of fact, the most effective level of resource management in the end is probably at the county level, the local level. And one of the states' major functions might be to improve and enhance the counties' abilities to manage the resource within their locale because they're closer to it still.

RITA COLWELL

There's been some legislation proposed that we should have a Chesapeake Bay coordinating group. Well, I think that has merit in terms of communicating who's doing what, where, and methods they're using, the results they've got. Coordination is fine, control is bad. I think we all can appreciate that discovery comes to the prepared mind, but discovery also comes to the individual who is free to explore and we should not curb the freedom to explore, to create, to understand.

NARRATOR

During the taping of this presentation we received many points of view. Each person had a different idea of where the balancing point should be. Somehow these differing viewpoints will have to reach an agreement to determine the policy that guarantees the balance for all concerned. Difficult task? Yes. But we found that despite the various ideas and opinions, there was an underlying sense of cooperation. Each person expressed a sincere desire to compromise, to talk with each other and to attempt to answer the question of balance.

OSWALD WILSON

Dredging, I guess, is the removal of the silt or sediments on the bottom of the creeks or river bottoms, Bay bottom, for the purpose of making the water deeper for navigation, for recreation, land developmwent. To me, it's the tool of the environmentalist. The soil washes overboard, the dredge sucks it up, puts it back on high land and the cycle starts all over again. They think it destroys a lot of the, let's say, ecological systems. I don't think there's been enough studies made on it yet to prove that it is detrimental to the ecology.

ROBERT DAVIES

A utility company's economic vitality depends upon the health of the community in which it works. We cannot afford to damage the Bay. We have a selfish interest to protect the Bay because only if the Bay is properly used by our citizens, by other industrial applications for transportation—whatever it takes to make our service area healthy from a personal point of view and also from an economic point of view—benefits our company. So we must maintain the maximum protection of the Bay in the way we use it.

LARRY SIMNS

We're not allowed to use trawls, or purse seines; we're not allowed to use electronic gear, like sonars, things of that nature. And we support that legislation. In an estuary such as the Chesapeake Bay, if you were allowed to use big trawls like they use in the ocean you could wipe the fish out. But with the type of gear that we're restricted to we can't wipe it out. We feel as though the commercial fisherman and the sportsfisherman, pleasure boaters can all live in the Chesapeake Bay together without being detrimental to one another. We don't see a need to have to fight.

ARLENE BAYBUTT

I'm sure that you'll find always somebody somewhere who's more interested in their pocketbook than in their surroundings or their future or others' future. But I would say that this county is especially concerned with the future of the county, the future of and the appreciation of our natural resources so that everybody in the county is concerned with conservation—everybody.

BILL BURTON

Well, we can. We've just got to buckle down and get things done. Young people have got to decide. They've got to decide what they want then go ahead and do it. You know, right now they've got fishing, they've got hunting, they've got waterskiing, they've got beachwalking, they've got swimming. They've got all these things. And if they want these things when they're older they've got to start working to save them now. They've got to start working now. They've got to realize, they've really got to realize it. There are not too many more generations that have this opportunity to go out there and work to save it.

ART SHERWOOD

It can be done. I mean, effective monitoring, effective care of an environment means that you're going to get a better environment. It's not a hopeless situation. The Bay right now is far from a terribly downgraded waterway. There's a lot of life left in it. The productivity is absolutely staggering. So it's not down-and-out by a long shot. But needless to say, all of us as human beings are alerted to the fact that it could be put down, it could be ruined, it could be just smashed. And I think as a human animal that we should be proud that we're sort of aware of this problem as we became aware of it and that we're doing something about it.

APPENDIX E

Elaborated Description of the Issues

1. **Recreational boating**
2. **Commercial shipping**
3. **Dredging and disposal of dredged materials**
4. **Harvesting aquatic resources**
5. **Tidal and nontidal wetlands**
6. **Shore erosion**
7. **Use of flood plains**
8. **Use of agricultural lands**
9. **Beach access**
10. **Onshore oil and natural gas facilities**
11. **Electric-generating facilities**
12. **Ports**
13. **Industrial parks**
14. **Residential development**
15. **Sewage treatment facilities**
16. **Land transportation facilities**
17. **Forested Lands**
18. **Mineral extraction**
19. **Channelization**
20. **Recreational, open-space, and natural areas**

1. Recreational boating

Recreational boating in Maryland is not only a popular pastime; it is also a Bay-related economic factor second in importance only to the port of Baltimore itself. In 1970, approximately $220 million was spent in Maryland on recreational boating. At present over 127,000 registered boats cruise the state's waters. This number increases nine percent each year.

The rapidly increasing popularity of recreational boating has caused an interrelated sequence of problems which need strengthened management efforts, thorough technical analyses, and creative solutions. Demand for marina facilities already exceeds existing capacity. More and more registered boats are trailered boats, which in turn have overflowed existing launch facilities. This shortage of boating facilities is further complicated by present local restrictions on marina development.

Increased recreational boating is also having the following adverse effects on the environment: (1) boating increases shoreline erosion and turbidity levels; (2) discharge of human wastes and other pollutants degrades water quality; and (3) safety and congestion problems have developed on some rivers that are heavily used for recreational boating.

2. Commercial shipping

The Port of Baltimore, a vital economic asset to Maryland and to the nation, is the major center of commercial shipping in Maryland. Each year the port generates more than $1.5 billion, which is 11.7 percent of the gross state product. In addition to the money injected into the state's economy by the industrial commercial, and transportation activities, the port provides jobs for approximately 249,000 Marylanders.

Several aspects of commercial shipping are of concern to the Coastal Zone Management Program: (1) the maintenance of adequate navigation channels; (2) the disposal of dredged material; (3) shore erosion aggravated by the boat wakes (waves); (4) the maintenance of the overall viability of the Port of Baltimore; (5) the establishment of a navigational safety system; and (6) the possibility of oil spills.

The state is concerned about oil pollution control, since between 1,100 and 1,200 oil spills were reported each year from 1974 to 1976. While many spills were in the 5–10 gallon range, at least 11 of the spills were in excess of 1,000 gallons; the largest spill was 135,000 gallons. Additionally, according to the annual report of the Oil Disaster, Containment, Cleanup and Contingency Program of the Water Resource Agency (WRA), it is conservatively estimated that 10 million gallons of waste oil and 3.5 million gallons of oil bilge and ballast waters (water in a ship to give the ship balance, that may also be contaminated with oil) are disposed of annually within the borders of Maryland.

Within the Chesapeake Bay, large oil spills can seriously damage waterfowl, wetlands, benthic communities, and shoreline property within a few hours. Similarly, the discharge of toxic materials, such as sulfuric acid, transported on the Chesapeake Bay can seriously damage aquatic resources.

A navigational traffic system to monitor vessel traffic on the Bay is needed to reduce the possibility of collisions. This will help prevent oil spills and the release of toxic materials. In addition, alternative methods of transporting oil, such as pipelines, should be investigated as means of reducing the potential oil pollution in the Chesapeake Bay and its tributaries.

3. Dredging and disposal of dredged material

In the past, dredged material from federally maintained harbor channels has been disposed of in open-water sites. The Maryland Board of Public Works, which designates such sites, is the only state organization authorized to acquire and dispose of submerged state lands. The adverse impact of disposed dredged material on shellfish beds was officially recognized by the Baltimore District U.S. Army Corps of Engineers in 1902. Throughout the years, watermen and environmentalists have objected to open-water disposal, and the last deepening of the C&D Canal (1966–1968) brought complaints from watermen that mounds of sediment were interfering with fishermen working near the area of disposal. In 1968, as a result of opposition to open-water disposal, the Commission on Submerged Lands of the State Board of Public Works made the following recommendations to the Governor and the Board:

1. The state make funds available for the study, planning, and construction of a spoil-containment area (a closed-off area to deposit dredged materials) near

Baltimore Harbor.

2. Pending completion of the spoil-containment area, dredging in Baltimore Harbor be severely limited, and spoil from those projects approved be deposited at Pooles Island Deep.

3. A westward extension of the Kent Island dump site be approved as proposed by the Baltimore district engineer, to receive noncontaminated spoil dredged outside Baltimore Harbor. This action was recommended by an *ad hoc* committee of estuarine experts only after consideration of the best available environmental information. According to this information, the environmental effects of disposing in the designated expansion area would be insignificant.

As a result of these recommendations, dredging in Baltimore Harbor was limited to critically needed projects. It also led to the selection of Hart-Miller Islands as a diked spoils-containment facility for the dredged material from the proposed deepening of the southern approach navigational channel to Baltimore Harbor from the existing 42-foot depth to 50 feet. The Hart-Miller dike was completed in 1983 and became operational in 1984.

Dredging operations may generate 155 million cubic yards (mcy) of dredged material over the next 20 years, 140 mcy of which will come from federal, state, and private dredging activities in Baltimore Harbor, the C&D Canal, and approaches. That total includes a federal program for deepening the Harbor approaches from 42 feet to 50 feet.

Existing containment sites along the C&D approach channel in Maryland have a total of 8.9 mcy of acceptable capacity. The current maintenance dredging backlog associated with the C&D channel is 10 mcy. Baltimore Harbor containment sites (privately owned) have a potential capacity of 2 to 4 mcy. Eight potential containment sites have been evaluated for development by the Maryland Department of Transportation in a report to the House of Delegates Subcommittee on Law Enforcement and Transportation. Together, these sites will provide approximately 30 mcy capacity. In summary, existing containment capacity is insufficient to meet spoil-disposal needs for the next 20 years.

4. Harvesting living aquatic resources

Living aquatic resources in the coastal environment are a major part of Maryland's recreational and commercial life and livelihood. The tremendous tonnage of fish and shellfish commercially harvested has been known for many years, and recently there has been evidence that the size of the recreational harvest of finfish is double that of the commercial catch. In addition, many migratory species found in the Bay are only parts of much larger populations that may span the entire East Coast. Harvest pressure, in the Bay and offshore, puts severe stresses on fisheries in Maryland's coastal zone.

In addition, agricultural runoff, excess sewage, storm water runoff, and industrial discharges adversely affect fisheries in the Chesapeake Bay and its tributaries.

Management decisions regarding the harvesting of the Bay's aquatic resources raise major scientific, social, and political questions.

5. Tidal and nontidal wetlands

Wetlands play a key role in Maryland's estuarine environment, providing basic nutrients in the food chain and habitat for many fish and wildlife species. They also help to protect water quality, inhibit flooding, and control shore erosion.

Prior to 1970, protection of Maryland's wetlands was limited, and controls over dredging and filling of wetlands were based on navigation rights rather than on ecological impact. Inadequate protection resulted in the loss of an estimated 23,777 acres of wetland area between 1942 and 1967. There is still considerable pressure to alter tidal wetlands.

Nontidal wetlands play an integral role in coastal ecosystems. They provide valuable wildlife habitat and food, particularly to waterfowl and fur-bearing animals. Many types of rare or unique plant species are found in these wetlands. They also play an important hydrologic role as buffers by moderating the effects of storm-water runoff, providing aquifer recharge areas (areas where water can be absorbed back into the earth), and filtering out sediments and pollutants contained in these waters.

Because of their natural value, nontidal wetlands are important to coastal zone management. Drainage projects for increased agricultural production; filling for residence-construction sites and other urban projects; filling for road, bridge, or utility crossings; and upland projects that modify the volume, velocity, and quality of runoff are all examples of alterations that may destroy the natural value of nontidal wetlands.

Some nontidal wetlands are currently under federal (Army Corps of Engineers) or state (Water Resources Administration) jurisdiction. Regulations alone, however, fall short of a comprehensive management program preserving the integrity of these areas, and more information is needed to establish this program.

Wetland areas that are within the 100-year flood plain of rivers are regulated both by the state watershed permit and the U.S. Army Corps of Engineers Section 10/404 permit systems. General permits have been issued by the Corps of Engineers for use of wetlands above the "headwaters" of a stream (the point where the median flow is less than five cubic feet/sec.). Projects that involve the filling of the uphill fringe of the flood plains of streams draining less than 400 acres are exempt from state watershed permits. Wetlands associated with water bodies of 1-10 acres, which are not part of a tributary system, are subject only to the requirements of the Corps of Engineers' general permits (unless a project may have significant impact). Areas not subject to individual permit requirements may constitute a significant portion of the state's nontidal wetlands.

6. Shore erosion

Areas undergoing significant shore erosion make up a large part of Maryland's coastal zone. Approximately 140 miles of Chesapeake Bay shoreline lose four feet or more every year. Shore erosion is a natural process that transports material necessary to maintain beach areas. Use of waterfront property, however, may be hindered by high erosion rates. Conversely, activities on the Bay and its shoreline often aggravate shore erosion. Sediment from shore erosion may cover oyster beds and fill tidal creeks and inlets. Inappropriate use of shoreline areas may upset natural processes and may even endanger human life and property.

On the Atlantic Coast, storm-induced shore erosion has adversely affected the beaches in front of Ocean City, and threatened property and human safety.

Because of the concern over shore erosion in Maryland and other coastal states, the 1976 amendments to the Coastal Zone Management Act included a requirement that all states, as part of their coastal zone management program, develop a "planning process" for (a) assessing the effects of shoreline erosion; and (b) studying and evaluating ways to control or mitigate the impact of such erosion, and to restore areas adversely affected by such erosion.

7. Use of flood plains

The danger to life and property due to flooding in Maryland's coastal counties is a major concern to the state Coastal Zone Management Program. A major storm on Easter, 1962 caused damage in the millions of dollars to public and private property on Maryland's oceanfront. Tropical storm Agnes (1972) killed 17 people and caused more than $110 million worth of damage to land and $134 million damage to fishing and related industries on Chesapeake Bay. Hurricane Hazel (1954) and a similar but more severe storm in 1933 inflicted major damage on Maryland's coastal areas, including tidal flood plains on the Eastern Shore.

Construction on and development of flood plains, which may increase the magnitude and frequency of serious flooding problems, worsen the impact of these storms. Such development may also adversely affect valuable biological resources found in flood plain areas.

8. Use of agricultural lands

Much of Maryland's coastal zone is rural. In the coastal counties, over 1,000,000 acres of land divided among more than 10,000 farms are committed to agricultural uses. Agriculture is a major part of the coastal economy, and it adds to the area's character and scenic beauty. Increased housing development, including the demand for second homes, however, is consuming much of Maryland's productive agricultural land. Conflicts have arisen between agricultural activities and coastal activities that depend on the aquatic environment. Farming has been identified as a contributor to nonpoint-source pollution. Conflicts often arise between farmers who wish to maintain or increase the drainage of agricultural land through stream channelization and groups who represent fish-and-wildlife interests.

9. Beach access

A beach is defined as a gently-sloping shore area of a body of water, which is covered by sand or similar material, and the lower portion of which is washed by waves or tides.

The only extensive beach areas in Maryland lie along the Atlantic coastline on Fenwick and Assateague Islands. There are also less extensive beach areas on the Chesapeake Bay.

The Maryland Department of Transportation gives considerable attention to providing an adequate transportation network between the Atlantic Coast beach areas and the heavily populated Baltimore-Washington area, where the majority of the beach users live. In the mid-1970s a second bridge was built across the Chesapeake to reduce traffic delays, and studies are underway to reduce potential bottlenecks at Kent Narrows, Vienna, and Cambridge. The alternatives to these bottlenecks need careful examination since the removal of wetlands and/or existing development may be involved.

Due to the isolated, nonextensive, narrow beaches of the Chesapeake Bay shoreline, there are few beach areas where the wetland sand areas alone can be used for intensive recreation even if access were provided. Therefore the provisions of public access must include the acquisition of upland areas to provide adequate recreational facilities.

In addition, sea nettles that invade the Bay and the Bay's warm summer temperature reduce its attractiveness for water-contact recreation compared to the state's Atlantic Coast beach areas. However, the Bay is heavily used for recreational boating purposes, and the state is committed to providing adequate boating access through its Waterway Improvement Program.

10. Onshore oil and natural gas facilities

The United States Department of the Interior is leasing tracts of the nation's outer continental shelf (OCS) to increase domestic production of oil and gas. The resulting increase in exploration, development, and production of offshore petroleum resources is likely to affect a number of communities along the Atlantic Coast. The lease sales (bids on leases) affecting Maryland are made periodically.

The locations, types, numbers, characteristics, and timing of onshore support and processing operations for outer-shelf activities are triggered by offshore events and activities. Viable discoveries of oil and gas reserves may create the need for several types of onshore facilities—including fabrication yards, service bases, pipeline facilities, various types of production terminals, refineries, auxiliary industrial facilities, gas treatment plants, and marine terminals. Each type of facility is associated with a different, sometimes overlapping, phase of the outer-shelf development process, and each has varying economic, labor, income, environmental, and social effects on existing community conditions.

At present, it is not known how much oil and gas exist off Maryland's coast. There have been only a few deep exploratory wells in the Baltimore Canyon Region (off the Maryland, Delaware, and New Jersey coasts).

The U.S. Geological Survey estimates that as much as .5 to 2.5 billion barrels of crude petroleum, and 2.5 to 13 trillion cubic feet of natural gas may be discovered and produced over a 25-year period. On the other hand, the possibility also remains that there are *no* recoverable hydrocarbons in the Mid-Atlantic OCS. In November 1984 Shell Offshore, Inc. found no commercial qualities of oil and gas in a deep-water exploratory well in the Mid-Atlantic area.

11. Electric-generating facilities

In the production and distribution of electricity, conflicts among environmental constraints, citizens' preferences, and economic issues have been widely publicized. Recognizing the controversy, the state of Maryland established a Power Plant Siting Program (PPSP) in 1971. The charge to the PPSP was to ensure that natural and socioeconomic environments be protected as Maryland's demand for energy grows.

Higher fuel costs and energy conservation programs by industry, commercial establishments, and individuals have slowed the rate of growth of Maryland's energy demand to about 2% per year. Even at this low rate of growth several existing plants will need to be expanded (plans are underway) and new plants built to meet energy requirements by the year 2000.

A relationship between "acid rain" and power plant emissions exists. The growing public realization of the effects of acid deposition on Maryland's environment has now become a major concern when considering how best to meet our energy needs.

Maryland has one significant hydroelectric facility in its coastal zone: the Conowingo Hydroelectric Project located on the Susquehanna River between Harford and Cecil Counties. The reservoir created by this project extends into Pennsylvania. The project consists of the dam, the powerhouse, the reservoir, and the transmission lines. The powerhouse has a total capacity of 512,000 kw and is owned and operated by the Susquehanna Power Company and the Philadelphia Electric Company.

In 1965 four additional turbines went into operation at the powerhouse. Since then, Maryland has experienced a number of fishkills downstream from the dam. Studies conducted by Maryland indicate that these fishkills are due to low dissolved oxygen conditions and a constantly changing water column below the dam as seasonal demand for electricity restricts the release of water from the dam.

Of concern are the adverse effects of dam operation on fishery production, aquatic habitat, water quality, water supply, and salinity. Maryland supports measures that will mitigate such effects and protect the natural resources and users of downstream areas between the Conowingo Dam and the Chesapeake Bay.

12. Ports

The ports of Maryland, including Baltimore, Cambridge, and Salisbury, comprise major economic enterprises that serve the import, export, and regional waterborne commerce of Maryland and the nation. Other ports, such as Piney Point, are single-purpose ports. Collectively, these ports provide substantial employment and income to the state.

The Port of Baltimore contains a mix of activities related to waterborne commerce such as: (1) public marine terminals operated by the Maryland Port Administration; (2) private marine-oriented industries such as Bethlehem Steel and Sea-Land; (3) railroad and road on-off loading centers; and (4) agricultural processing operations such as the Amstar sugar refinery.

The Port of Cambridge, developed with public funds by the Maryland Port Administration, serves the agricultural industry on the Eastern Shore.

Salisbury's port is privately developed and operated to receive refined oil products, agricultural products, and dry bulk goods.

Piney Point receives and stores refined oil products for use in southern Maryland.

Existing port areas in the state, as well as proposed future port areas, are being studied to determine what types of new port-related activities might be stimulated by new port facilities. Baltimore Harbor is Maryland's largest economic entity as well as the largest, most diversified port. Expansion needs for Baltimore Harbor are being studied. Studies investigating the feasibility of a commercial port at Crisfield are also underway. There is increasing support for the idea of limiting the competition of the Eastern Shore ports by emphasizing the concept of a regional port complex involving Crisfield, Cambridge, and Salisbury.

Port development can have major environmental consequences, especially in relatively undisturbed areas. The dredging required to build and maintain navigation channels can change the hydrology of a harbor, cause salinity variations, degrade existing aquatic resource values, and create a disposal problem. In addition, ports that handle oil products involve risks of oil and/or liquid natural gas spills. Ports also have landside impacts; since a port generates a large volume of rail and heavy truck traffic, it usually spurs intensive industrial and urban development.

13. Industrial Parks

An industrial park is generally defined as land under one management that provides facilities useful for several kinds of industries. The development of a park is based on a comprehensive plan containing land-use requirements regarding: (1) street design, facilitating truck and other traffic; (2) rail and utility layout; (3) proper setbacks, minimum lot size, floor-area ratios, and buffer zones; (4) architecture and landscape requirements; and (5) off-street parking and loading regulations.

The average size of an industrial park in the United States is 312 acres, although projects in excess of 500 acres are becoming commonplace [Urban Land Institute,1975]. The size of an industrial park is determined by: (1) market demand; (2) absorption rate of the development period; (3) the constraints of available sites; and (4) the nature and extent of government regulations.

An industrial park accommodates a variety of uses: (1) manufacturing; (2) warehousing and distribution facilities; (3) research and development; and (4) commercial uses. A broad range of manufacturing activities are locating in industrial parks, as they are more suitable for warehousing and transportation.

The marketability of the industrial park concept is of great importance to the local community, and their locations are attractive to industry for the following reasons: (1) the presence of related industries; (2) the availability of utilities and transport services; (3) the compatibility of contiguous land uses; and (4) the savings resulting from the absence of traditional start-up costs.

The extent of environmental and socioeconomic impact on the area around an industrial park depends upon the size of the park, its resident industries, and prevailing conditions in the surrounding area.

The advantages of Maryland's geographical position are widely recognized by American industry. The state lies at the center of a large multistate economic region encompassing the northeast, southeast, and midwest market areas. Also, Maryland's industry is diverse; a large number of types of industries are located in Maryland (363 out of 451 industrial types).

Maryland provides industries with a variety of site choices and locations. Industrial park locations include both urban and suburban settings in places such as Baltimore, Salisbury, Cambridge, and Easton. All but Easton offer sites for water-oriented industries. Local municipalities and counties have zoned lands for industry, or are establishing industrial districts on municipally owned land. The city of Crisfield in Somerset County is currently investigating the feasibility of a port-oriented industrial park to serve the agriculture industry on the Eastern Shore.

14. Residential development

The shorelines of the state are becoming more popular for large residential developments, both seasonal and permanent. The construction of such facilities may cause the following adverse impacts: (1) excess of the carrying capacity of areas to support such facilities; (2) excess of the capacity of local communities to provide public services for them; (3) increased sedimentation and nonpoint-source pollution problems; and (4) destruction of areas that contain valuable natural resources, including wildlife habitat and productive agricultural land. These residential facilities may also bring the construction of public facilities such as sewage-treatment plants and highways, which in turn promote more growth.

15. Sewage-treatment facilities

More sewage-treatment plants are being located with outlets on Maryland's tidal waters. However, the rate of treatment-facility construction has not kept up with the rate of development in Maryland's coastal zone, and existing facilities are overtaxed and operating at decreased efficiency. Although there is a need to proceed as quickly as possible to meet the need for new and improved facilities, the situation presents several concerns to the Coastal Zone Management Program.

1. Conflicts occur between sewage-treatment plants and other users of tidal waters—particularly the growing and harvesting of shellfish. Shellfish sanitation regulations require an extensive buffer area around the outlet point, thus closing the area to shellfish harvesting regardless of the level of treatment. On the other hand, evidence that improperly treated sewage is entering tidal waters can mean closure of even greater waste areas to shellfish harvesting. Chlorine has been found to be toxic to aquatic organisms, particularly in the egg and larval stages, and is now required to be removed at treatment plants adjacent to spawning areas.

2. Developers and land speculators know that sewage-treatment plants of large capacity promote development. Building major new sewage-treatment plants in coastal areas may increase high-density growth along shorelines where only low-density development was formerly allowable under health standards regulating the installation of private facilities, particularly septic tanks.

3. Sewage facilities have the potential for major water-quality impact beyond the health-related considerations mentioned earlier. Oxygen-depleting materials, nutrients, and residual chlorine are the most important components to be considered. The state has formulated regulations and policies about the removal of these substances and has issued discharge permits, based on local area and Baywide studies. The present policies and discharge permits cannot be considered the final solution to all problems. Only additional research, especially the monitoring of the water-quality changes effected by the present policies, will allow clarification of the remaining issues. More investigation of alternative methods of sewage treatment, such as landside disposal of effluent by spray irrigation, sand mounds, etc., are needed.

4. The physical location of new treatment facilities and the discharge of their effluents often affects coastal resources such as upland natural areas, tidal wetlands, and aquatic resources.

16. Land transportation facilities

In the past 20 years, the development of transportation facilities has played a major role in shaping the uses of Maryland's coastal areas. Beltways around Baltimore and Washington, D.C. have contributed to the movement of populations from cities to the suburbs. Service facilities catering to through traffic have developed along rural interchanges of limited-access highways. Businesses in these locations usually have such small local markets that they would not be able to support themselves without the highways. Thus the highways provide economic gain to the community, and may be a central factor in the community's economy.

In suburban areas around cities, radial highways and beltways have drawn businesses and households away from downtown areas and have helped create more dispersed housing and employment centers.

If there is easy access to and from the highway, a "strip" of stores, restaurants, motels, gas stations, and apartments can develop along the sides of the highway. Single-family housing may spread out behind these strips on the many crossing roads.

If the highway has limited access, interchanges develop, and cross-streets may become major arteries with their own strip development or office parks. The highly visible land along the road may be developed through construction of frontage roads.

Highway projects involve engineering activities associated with the construction, operation, and maintenance of the highway (that is, land clearing and stripping, the use of herbicides, the application of road salts, and slope stabilization). These, and activities after the highway is completed (for example, deposits of heavy metals and petroleum wastes from automobile exhaust and tires), can influence both the terrestrial and the aquatic environments of the immediate project areas, and often have more remote effects from sedimentation and stormwater runoff.

Proposed highway projects of concern in the coastal zone include the Patuxent Freeway in Anne Arundel County, and Route 50 improvements between Kent Island and Easton, and at Vienna, Cambridge, and Salisbury.

Other types of transportation facilities besides highways are significant for coastal resources and activities. Baltimore and Washington, D.C. rapid transit systems are being constructed to alleviate transportation problems. Construction of these systems involves questions of fiscal impact due to costs, areas to be served, and potential for growth generation.

17. Forested lands

The importance of timber products and the value of private and public forests as natural buffers, wildlife habitat, and recreational areas show the need for sound management of woodlands. Most of Maryland's 1,535,000-acre coastal forest area is privately owned and is under the owners' care and management. However, other groups such as the forest product industry, recreationists, public agencies, and the public at large also influence the use of private forest lands. There are four state forests totalling approximately 20,000 acres in the state's coastal zone: Doncaster State Forest in Charles County; Elk Neck State Forest in Cecil County Wicomico State Forest in Wicomico County; and Pocomoke State Forest in Worcester County. These forest areas provide a variety of products and services including timber products, wildlife habitat, watershed protection, and recreational activities.

18. Mineral-extraction facilities

Sand and gravel have been defined as "continuously graded, unconsolidated materials that appear in the earth's surface, generally resulting from the natural disintegration of rocks."

Estimated sand and gravel supply in southern Maryland is 3.6 billion tons. However, there is no published estimate of accessible sand and gravel deposits that might produce economic yield. In metropolitan areas many deposits have been covered by urban and suburban development, and in some areas mining conflicts with other land uses. It is estimated that a 10-to-15-year supply for general construction does exist within the state. In areas where there is sand and gravel, the feasibility of mining depends on a number of factors, and onsite inspection and core drilling is usually reguired.

The Maryland Geological Survey is currently compiling information on sand and gravel resources, based on literature review, field investigation, aerial photographs at 1:20,000 scale, LANDSAT photographs, and personal communications with operators and mapping geologists. The end result of this project will be the publication of a mineral-resources map for each county.

Total combined commercial consumption was more than 12.5 million tons in 1973, valued at close to $30 million. Over 98% of the sand and gravel used in Maryland was transported by truck, and less than 2% was transported by rail. There are approximately 150 active sand and gravel operations in Maryland. However, there are numerous borrow pits (quarries) which are less than one acre in size and are not included in the above estimate.

Three distinct methods of sand and gravel removal are practiced: (1) dry pit; (2) wet pit; and (3) dredging of rivers, bays, and oceans. In the dry-pit method, sand and gravel are removed from above the water table. 50% of current production is from dry pits. The wet-pit method—accounting for 35% of current production—is a land method by which materials are removed by dragline or barge-mounted dredges from above and beneath the water table. Dredging—accounting for 15% of current production—recovers sand and gravel from lakes, bays, rivers, and estuaries.

In a typical operation, sand and gravel are processed prior to transport to the user. Excavated materials are dumped into a hopper; after passing through separation screens, gravel and rock are separated and crushed. The remaining materials are pumped to a hydroseparator and sandscrew separator, where coarse sand is cleaned and removed. Fine sand is then similarly treated. The sized, cleaned products are then stored separately, ready for transportation to the user.

A by-product of processing is the waste effluent, which is generally treated in holding ponds where a high concentration of suspended solids is removed. In many cases, operators are able to maintain closed systems whereby the processing water is recycled continuously.

Disposal of waste products from process waters is a serious problem for many operators. Where available, already-disturbed areas such as those previously mined are used. However, space for disposal is not often available, and it is expensive when it is available.

19. Channelization

Channelization, the modification of natural stream channels, is a method used in Maryland to increase the productivity of agricultural land and reduce the frequency of damaging floods. Channelization includes the following alterations of natural stream courses: (1) lining of a channel; (2) clearing obstructions and accumulated bedload material; (3) widening; (4) deepening; and (5) realignment of existing channels. These modifications move water off the land at an increased rate and volume, thus reducing the potential for damage by flooding. Channelization can also lower the existing water table adjacent to the modified channels, increasing the permeability and productivity of the soil. Channel modifications are often part of small watershed projects that also may include impoundments or reservoirs for flood control, sediment control, and recreation.

Several environmental problems are often associated with channelization: (1) deterioration of water quality; (2) protection of water quality from the transport of agricultural chemicals; (3) construction of channel modifications creates sediments; and (4) the removal of stream-bank vegetation increases sediments and increases water temperatures. The impairment of water quality interferes with the spawning of fish and the growth of beneficial aquatic vegetation. The location of channel modifications often involves nontidal wetlands, particularly on the Eastern Shore. Activities in these wetlands can reduce or destroy the valuable functions of wildlife habitat, sediment entrapment, and groundwater recharge.

20. Recreational, open space, and natural areas

The population in Maryland's coastal zone has increased greatly within the last decade. Increased leisure time, greater purchasing power, and the desire to escape congested living for outdoor relaxation and recreation have had a significant impact on the coastal zone. Many people have chosen to live and work near the shoreland areas. Many more have chosen to live near the shore and commute great distances to and from work in order to enjoy evenings of recreation in coastal areas. Still others, employed and residing in metropolitan areas, seek recreation in Maryland's coastal zone on weekends and holidays.

Accompanying the rapid rise in population has been a growing need to protect open space and natural areas in order to provide sufficient wildlife habitat, to maintain wildlife populations, and to meet the increasing demands for active and passive recreation opportunities and "wilderness experiences."

The state parks, forests, and wildlife management areas in Maryland's coastal counties are only a small fraction of Maryland's shoreline. Additional recreational and natural areas adjacent to the shoreline are needed. The state has purchased one such area, 2,700-acre Wye Island, to ensure that it is maintained as one of Maryland's last undeveloped islands.

Two sites in Maryland have been proposed as national estuarine sanctuaries: the Rhode River in Anne Arundel County, and Monie Bay in Somerset County. Research and educational activities which contribute to a better understanding of these valuable resources will be the focus of management activity at these sites.

APPENDIX F

Public Policy Action Format

A. Public Policy—Action Format

Public Policy is defined as a legal course of action, with a stated source of financial support, which leads to a desired goal.

A *goal* is an outgrowth of an identified and debated issue. For example:

Issue: Tidal wetlands
Goal: To save the wetlands from destruction
Method: *Direct regulation*—eminent domain and permits

Public Policy Statement: Preserve the most productive areas and approve the development (on a case-by-case basis only) of only the less productive areas. Preserved wetlands to be purchased from tax revenues.

B. Major methods available for developing public policy

1. *Direct regulation:* The use of licenses, permits, eminent domain, compulsory standards, and other regulations to manage the Chesapeake Bay environment. *Eminent domain* is defined as the right of the government to take private property for public use. The owner must be paid compensation for the property taken.
Advantages:(a) Maintains the environmental impact below a permanently damaging level; (b) Can be better than outright prohibition because it provides for individual exceptions and for unique community needs.
Disadvantages: (a) Difficult to enforce, especially when there is a large number of pollution sources. (For example, the many thousands of recreational and commercial boats on the Bay; (b) Standards selected tend to be those that are enforcable rather than optimal, and few incentives exist for people to reduce the environmental impact below the acceptable standards; (c) Large ecosystems such as the Chesapeake Bay do not usually follow political boundaries. Therefore, effective regulation by one governmental unit may be nullified by the inaction of another; (d) Courts and administrative procedures can long delay compliance with regulations; (e) Regulations often treat all violators alike. This can discriminate against the small polluter. For instance, the small marina owner may be fined a greater percent of his income for oil spills than large corporations.

2. *Tort system:* Sue individuals or groups for harming the Chesapeake Bay environment.
Advantages: Permits reimbursement for damages.
Disadvantages: (a) Major problems of documenting the type of harm (especially long-term), the degree of harm, and who is responsible; (b) Suing can be a long-term, expensive venture which does little to prevent future harm.

3. *Moral persuasion:* Persuade individuals to stop voluntarily from harming the Chesapeake Bay environment as an ethical responsibility.
Advantages: Motivates Bay citizens to make decisions for the common good.
Disadvantages: Individual efforts can be negated when finances reward those not persuaded. For example, a waterman who restricts his catch to the legal limit loses money relative to other watermen who do not limit their catches.

4. *Prohibition:* Pass and enforce laws to manage the Chesapeake Bay environment.
Advantages: Prohibits from the Chesapeake Bay environment any substances, acts, etc., that might harm the ecological balance.
Disadvantages: (a) May be neither economically nor politically viable; (b) Total prohibition is very expensive to obtain and is not always necessary. For example, natural chemical cycles can recycle some pollutants.

5. *User rights:* Sell on the open market a limited number of rights to use the environment for waste disposal, etc., up to a specified amount in a given place during a particular period of time. The total amount of rights sold is calculated not to exceed minimal environmental impact.
Advantages:(a) Produces rather than drains limited public funds; (b) May decrease political intrigue to influence regulatory agencies.
Disadvantages: (a) Difficult to determine charges for user rights; (b) Could lead to unfavorable international trade to and from ports on the Chesapeake Bay, because prices could increase to cover the user rights charges; (c) Can be labeled a "right-to-pollute" method.

6. *Payments and incentives:* Direct payments, subsidies, forgiveness or reduction of taxes, tax credits, etc., for control devices and other efforts to reduce the impact on the Chesapeake Bay environments.

Advantages: (a) Makes it profitable not to impact the Bay environment and encourages the reduction of environmental impact to low levels; (b) Reduces the need for enforcement.

Disadvantages: (a) May encourage people or industries to pollute so that they can qualify, thus draining limited public funds; (b) Environmental impact costs are not incorporated in the price of goods and services.

C. Examples of Public Policy Statements for recreational boating and marina development

Issue: Recreational boating and marina development

Example I

Goal: To restrict marina development, and to research more environmentally sound marinas

Method: *Direct regulation*—taxes, permits, and building codes

Public Policy Statement: Restrict marina development capacity for the recreational boats on the Bay and tributaries. Restrict development through property, development, and fuel taxes, boat slip rentals, and fines. Money for research for more environmentally sound marinas is to be obtained from taxes, water conservation fund, and state and federal grants.

Example II

Goal: To create incentives to encourage the use of sailboats rather than motorboats

Method: *Payments and incentives*—Lower docking rates and preferred docking locations for sailboats, versus higher docking rates and higher fuel taxes for motorboats

Public Policy Statement: Encourage sailboats through preferential treatment at the marina, and lower docking rates. Discourage motorboats through higher fuel taxes and docking fees. Use these measures to help control the quality of the Bay's water.

Example III

Goal: Ban or restrict further marina development

Method: *Prohibition*—Establish and enforce standards to protect the environment by banning all new marina development. Restrict existing marinas to maintenance only, with no new development

Public Policy Statement: Prohibit any new marina development and boat ramp development. Restrict existing marinas and boat ramps to necessary maintenance only.

Example IV

Goal: To develop larger marinas

Method: *User rights*—Sell on the open market the right to double the size of existing marinas in the next five years

Public Policy Statement: Expand facilities to meet the needs for docking and servicing boats. Money will be allotted by the Coastal and Life Waters Association through very low-interest loans to expand marinas and/or boat ramps, with a four-year period before the first loan payment falls due.

APPENDIX G

Environmental Impact Statements: Their History and Purpose

National Environmental Policy Act

On January 1, 1970 President Nixon signed into law the National Environmental Policy Act (NEPA) which declared a national policy to encourage productive and enjoyable harmony between man and his environment. In an attempt to ensure that environmental values are given equal consideration with economic and technical data, NEPA requires each Federal agency to prepare an environmental impact statement (EIS) in advance of any major action, recommendation, or legislation that may significantly affect the quality of the human environment. The purpose of an EIS is to assess in detail the potential environmental impact of a proposed action. An agency prepares a *draft* EIS for review by appropriate Federal, state, and local environmental agencies, as well as the public; this draft EIS is circulated for comment at least 90 days before the proposed action. After comment from interested parties, the statement is prepared in *final form*, incorporating all comments and objections received on the draft and indicating how significant issues raised by the draft EIS have been resolved. Both draft and final statements are filed with the President's Council on Environmental Quality (CEQ) and made available to the public at least 30 days before the proposed action, usually through announcements in the *Federal Register*.

Each environmental impact statement should include the following information:

1. A detailed description of the proposed action, including information and technical data necessary to permit a careful evaluation of environmental impact.
2. Discussion of the probable impact on the environment.
3. Any adverse environmental effects that cannot be avoided.
4. Alternatives to the proposed action that might avoid some or all of the adverse environmental effects.
5. An assessment of the long-term effects of the proposed action. In addition a *final* impact statement must include a discussion of problems and objections raised by other Federal, state and local agencies, private organizations, and individuals during the draft statement's review process.

Use of the EIS in the BIG Conference simulation

In 1971 the Department of the Interior developed a procedure for evaluating the environmental impact of departmental projects. Part of this procedure involves the use of a grid showing the relationship between existing conditions of the environment and proposed actions that could affect the environment. It is this grid that has been modified for use in the BIG simulation

As used in the simulation game the Environmental Impact Grid is a means of visually indicating how each policy developed by the interest groups would affect the environment. The grid allows the students to compare the environmental changes that each policy would dictate; for each proposed action the students must decide if the policy will have no impact on the environment or a slight, moderate, or severe impact.

An examination and definition of some of the terms in the EIS grid will help to clarify how the grid can be used. The terms are not mutually exclusive; some environmental actions may be listed under more than one category, but each category would include that action because of a different effect which it would have. For example, increased shipping traffic on the Bay would be listed in categories 7 (changes in traffic) and 10 (increased potential for accidents).

APPENDIX H

Example of a Final Report

I. **Issues and public policy statement:** A final report should first include the issue studied, for example, "Tidal Wetlands." A statement of the public policy developed about the issue should follow:

> "Preserve the most productive wetland areas through public acquisition from tax revenues. Only approve development on a case-by-case basis in wetland areas of low productivity."

II. **Outline of environmental impacts:** Environmental impacts either of the policy itself or of *not* enforcing the policy should follow, depending on the teacher's judgment as to which approach is more appropriate and workable, given the subject and class ability. The teacher should clearly communicate which approach is to be taken by the class. The following is an example of the second approach, specifically the environmental impacts of uncontrolled development of wetlands. The degree of impact of each public policy on the environment has been determined by the interest group through completion of the EIS grid. *The Chesapeake Bay Data Bank* and other data sources consulted by the group should be referenced in order to validate the various environmental impacts. An example of a completed EIS grid with a supporting narration and documented references is as follows for the above policy.

A. **Supporting narrative of the EIS grid** (each numbered set corresponds to the "Proposed Actions Having an Impact on the Chesapeake Bay"):

1. The ecosystem would be modified *severely* by disturbing the plant and animal life; *moderately* by changing the coastline of the Bay and its waters, altering portions of wetlands, altering the aesthetic quality, and altering the ecological relationships within the wetlands in question.
2. The land transformation could *severely* alter plant and animal life; *moderately* alter earth and water, aesthetic quality, and ecological relationships within the lands in question.
3. Resource extraction would not be a factor in this public policy statement, unless sand and gravel removal were considered.
4. Land-use activities and alterations would *severely* impact the plant and animal life; *moderately* alter the earth, water, and land use, aesthetic quality, manmade facilities, and ecological relationships; and *slightly* alter recreation and cultural status.
5. Land alterations would *severely* impact plant life and animals; and *moderately* impact earth, water, and land use, aesthetic quality, manmade facilities, and ecological relationships.
6. Resource renewal would not be a factor in this public policy statement.
7. Changes in traffic would *severely* impact plant and animal life and land use; *moderately* impact earth, water, aesthetic quality, manmade facilities and activities, and ecological relationships.
8. Waste treatment and disposal would *severely* impact plant and animal life, land use, and manmade facilities and activities; *moderately* impact earth, water, aesthetic quality, and ecological relationships.
9. Chemical treatment would *severely* impact plant life, animals, land use, manmade facilities and activities, and ecological relationships. Earth, water, and aesthetic quality would be *moderately* impacted.
10. Accidents could *slightly* impact manmade facilities and activities.
11. No other impacts are anticipated.

B. **References found in *The Chesapeake Bay Data Bank*** which support the EIS for this public policy statement include:

p. 6: *Estuaries:*

"Estuaries benefit from a diversity of productive plant types which provide year-round energy." An estuary fulfills the following functions for plants and animals:

1. It provides a habitat for a wide variety of organisms.
2. It is utilized as a nursery ground by fish.
3. It is a food source for ducks and brant.
4. The plants physically act as a stabilizing factor for bottom sediments.
5. Estuaries play a role in reducing turbidity.

(Impact factors 1, 2, 4, 5, 7, 8, 9)

p. 10 *Wetlands:*

The wetlands of the Bay region although accounting for only 3 percent of the total land area, are of crucial importance to the ecosystem of the Bay. . . All of the counties of the Bay region have some wetland areas of varying types and sizes, although it should be emphasized that not all wetland areas depend on such factors as the type of dominant plant, flushing action in the area which affects the availability of nutrients to the aquatic community, and the intensity of use of the wetland as habitat.

(Impact factors 1-5)

p. 17 *Wetlands (Future Land Use):*

Although no projections were prepared of future wetland acreages, it can be stated with a high degree of confidence that the demand for shoreline lands for such uses as marinas, vacation homes, or port facilities will increase in the future. However, more stringent Federal and State restrictions on the development or degredation of wetland areas along with a growing awareness of the ecological and economic importance of wetlands are likely to at least slow down the historic rate of wetland destruction in the Chesapeake Bay region. . . An Executive Order signed by President Carter in 1977 set more stringent guidelines governing Federal activities in wetland areas.

(Impact factors 1-9)

Executive Order 11990, The President of the United States, ***May 24, 1977;*** From the statement by the President accompanying Executive Order 11990:

> The unwise use and development of wetlands will destroy many of their special qualities and important natural functions. Recent estimates indicate that the United States has already lost over 40 percent of our 120 million acres of wetlands inventoried in the 1950's. This piecemeal alteration and destruction of wetlands through draining, dredging, filling, and other means has had an adverse cumulative impact on our natural resources and on the quality of human life.
>
> The problem of loss of wetlands arises mainly from unwise land-use practices. The Federal Government can be responsible for, or can influence, these practices in the construction of projects, in the management of its own properties, and in the provision of financial or technical assistance.
>
> In order to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative, I have issued an Executive Order on the protection of wetlands.

(Impact factors 1-9)

p. 61 *a. Marsh Creation:*

Marshes tend to buffer the shoreline wave action and its consequent erosive forces. Under certain conditions, marshes can be created by selective placement of material in nearshore zone. . . .could help solve the problem of finding acceptable disposal sites for dredged material.

b. Vegetation cover (wetlands):

In addition to improving the ability of the shoreline and fastland areas to resist erosion, the vegetation can trap windblown material and thus aid in the formation of a protective dune.

c. Regulatory actions and public awareness programs:

Land-use regulations can be used to set aside critically eroding reaches for such nonintensive uses as recreation or open space. This action would prohibit development of structures that would be threatened by a rapidly receding shoreline. A second approach is to adopt building codes which would allow for development in eroding areas but would require construction of appropriate erosion-control measures. The developer would be required to provide continuous protection for the length of the beach.

(Impact factors 1-6)

p. 65 *Nonconsumptive utilization of resources:*

The wetland and upland habitat as well as the waters of the Bay and its tributaries provide habitats which support an extensive variety of flora and fauna. . . Research indicates that the number of people in the U.S. in 1970 that participated in nonconsumptive outdoor activities (birdwatching, camping, swimming, hiking, photography) was about 9 percent higher than the number of people fishing and hunting. Aside from the enjoyment which is gained from an association with the natural resources of the area, the Bay, its tributaries, associated wetlands, and upland areas provide valuable educational services as a classroom for natural science studies.

(Impact factors: little . impact, but aesthetic and human interest, recreation, and human activities regarding the ecological relationships of the area would be served.)

III. **Agreed-upon proposals used to mitigate the negative impacts of this public policy statement:** Any development that takes place in the less productive areas of tidal wetlands must follow stringent regulations to prevent pollution from oil, chemicals, waste disposal, siltation, or any known substance that will impact the Bay environment. Taxes and permit fees to develop the approved wetland areas should be sufficient to cover costs to limit their environmental impact.

IV. **Final approved public policy:** Preserve the most productive wetland areas. Approve development for wetland areas of low productivity on a case-by-case basis with stringent regulations to prevent pollution from all known sources. Tax and permit fees to protect wetlands will be mainained at a sufficient level to cover environmental protection costs and to purchase additional productive wetlands for preservation.

V. **Projected effect of public policy by the year 2020:** More acreage of the wetlands areas will be purchased by the government for open spaces and recreation. More wetland acreage will leave the private sector either to government or to developers. The acreage of wetlands that is developed will undoubtedly have environmental impact on the Chesapeake Bay. There is no guarantee that the taxes and permit fees collected will continue to be designated for the purchase and preservation of public wetland areas. (see *Wetlands: Future Land Use* reference, p. 17, as outlined above.)

ENVIRONMENTAL IMPACT STATEMENT (EIS) GRID

		I. Proposed Public Policy Actions That May Have a Negative Impact on the Chesapeake Bay Environment									
		A	B	C	D	E	F	G	H	I	J
		Modification of Ecosystem	Land Transformation and Construction	Resource Extraction	Land Use Activities	Land Alteration	Resource Renewal	Changes in Traffic	Waste Treatment and Disposal	Chemical Treatment	Accidents
	Check off										
II. Degree of Negative Impact on Existing Chesapeake Bay Environmental Characteristics and Conditions for Each Policy (Scale: 0–3)	1	3	2		2	2		2	2	3	1
	Check off										
	2										
	Check off										
	3										
	Check off										
	4										

ENVIRONMENTAL IMPACT STATEMENT (EIS) GRID

		I. Proposed Public Policy Actions That May Have a Negative Impact on the Chesapeake Bay Environment									
		A	B	C	D	E	F	G	H	I	J
		Modification of Ecosystem	Land Transformation and Construction	Resource Extraction	Land Use Activities	Land Alteration	Resource Renewal	Changes in Traffic	Waste Treatment and Disposal	Chemical Treatment	Accidents
	Check off										
II. Degree of Negative Impact on Existing Chesapeake Bay Environmental Characteristics and Conditions for Each Policy (Scale: 0–3)	**1**										
	Check off										
	2										
	Check off										
	3										
	Check off										
	4										

APPENDIX I

Chesapeake Bay Agreement of 1983, Maryland Chesapeake Bay Program

We recognize that the findings of the Chesapeake Bay Program have shown an historical decline in the living resources of the Chesapeake Bay and that a cooperative approach is needed among the Environmental Protection Agency (EPA), the State of Maryland, the Commonwealths of Pennsylvania and Virginia, and the District of Columbia (the States) to fully address the extent, complexity, and sources of pollutants entering the Bay. We further recognize that EPA and the States share the responsibility for management decisions and recourses regarding the high priority issues of the Chesapeake Bay. Accordingly, the States and EPA agree to the following actions:

1. A Chesapeake *Executive Council* will be established which will meet at least twice yearly to assess and oversee the implementation of coordinated plans to improve and protect the water quality and living resources of the Chesapeake Bay estuarine system. The Council will consist of the appropriate Cabinet designees of the Governors and the Mayor of the District of Columbia and the Regional Administrator of EPA. The Council will be initially chaired by EPA and will report annually to the signatories of this Agreement.
2. The Chesapeake *Executive Council* will establish an implementation committee of agency representatives who will meet as needed to coordinate technical matters and to coordinate the development and evaluation of management plans. The Council may appoint such ex officio nonvoting members as deemed appropriate.
3. A liaison office for Chesapeake Bay activities will be established at EPA's Central Regional Laboratory in Annapolis, Maryland, to advise and support the Council and committee.

The Bay Clean-Up Effort

In December, 1983 the governors of Maryland, Virginia and Pennsylvania joined with the mayor of Washington, D.C. and the Environmental Protection Agency in signing the Chesapeake Bay Agreement of 1983.

The State of Maryland immediately responded to the call to clean up the Chesapeake, approving 34 legislative initiatives and focusing these into 7 state programs, known as Maryland's Chesapeake Bay Program. Here is a list of those seven initiatives, with a little about each one. The original 1984 appropriation by the Maryland legislature for the Program called for about $36,000,000 as Maryland's support for the clean-up crusade.

Initiative A: The first initiative focuses on **point-source pollution,** pollution that comes from a pipe (usually from a waste treatment plant, an industry or a power plant). Different parts of this initiative call for taking chlorine out of treated waste at many sewage plants, for reducing nutrients from sewage plants and for punishing industries and others that break pollution control laws.

Initiative B: This initiative calls for more "best management practices" on area farms to reduce **nonpoint-source runoff,** runoff that doesn't usually come from a pipe but from the land itself. Other parts of this initiative focus on housing developments and urban areas, also sources of damaging sediments and runoff. One of the most difficult problems results from nutrients (especially phosphorus and nitrogen) that run off the land.

Initiative C: This initiative deals with **resource restoration,** bringing back the fish and the habitat that has historically made the Chesapeake the nation's richest estuary. Specifically, this initiative supports placement of oyster shell and planting of submerged grasses.

Initiative D: In order to protect the Bay, it became clear that the land surrounding the Bay had to be protected. Through the **protection of land resources,** the state will help preserve valuable wetland areas and woodlands. It is this initiative which calls for the establishment of a Critical Areas Commission to review management and development of lands in and around the Bay.

Initiative E: To assure that future Bay citizens understand the nature of the value and vulnerability of the estuary, this initiative calls for the enhancement of **Bay-related education** efforts. Grants will go to individual school systems, to the University of Maryland, and to the Chesapeake Bay Foundation to foster marine education. The reprinting of this book largely results from that support.

Initiative F: Understanding whether or not these programs are having a positive effect on the Bay will require careful **research and monitoring.** This initiative supports those activities, as well as a data bank which will pull together information from all over the estuary.

APPENDIX J

Introduction to the Chesapeake Bay

Purpose

To provide students with an overview of the Chesapeake Bay and its environmental setting.

Suggested Lessons

Depending on student background and available time, the teacher can select from a variety of lessons that will help students develop an adequate perspective on the Chesapeake Bay. This activity may vary from fifteen minutes to two or more class periods. This activity should make the student aware of the complexity and importance of the Bay, and should not teach a lot of detail about the Bay. This will come later during the Bay Interest Groups (BIG) Conference simulation, when the *Chesapeake Bay Data Bank* and other information sources are used extensively to support issues and develop public policy. The primary goal of both this activity and the videotape presentation in the following activity should be to encourage student participation in the BIG simulation.

Lesson 1: Direct a "brainstorming session" about the Chesapeake Bay.

1. Prior to the brainstorming, the teacher should preview for background:

(a) The slide/tape presentation "The Chesapeake Bay: What It Is to You" as outlined in Lesson 2.

(b) Both maps—"Generalized Land-Use Patterns of the Chesapeake, 1970" and "Projected Land-Use Patterns of the Chesapeake Bay Region, 2020"—as outlined in Lesson 3.

(c) "The Chesapeake Bay Fact Sheet" as outlined in Lesson 4.

(d) The videotape "A Question of Balance" as outlined in Activity 1.

(e) The "Environmental Setting" portion of the *Chesapeake Bay Data Bank.*

(f) Three highly recommended sources are *Integrity of the Chesapeake Bay,* compiled by the Maryland Department of State Planning; *The Chesapeake Bay in Maryland: An Atlas of Natural Resources,* by Lippson, Johns Hopkins University Press; and *Chesapeake Bay: An Introduction to an Ecosystem,* U.S. Environmental Protection Agency. All three are cited in the Bibliography.

2. The teacher should begin the brainstorming session by asking several of the following (or similar) questions. Answers are provided where appropriate.

(a) Have you been on the Chesapeake Bay? Where? How often?

(b) What do you like about the Chesapeake Bay? What do you dislike?

(c) How large is the Bay?

The Bay has a surface area of about 4,400 square miles, is 200 miles long and 4 to 30 miles wide with over 7,000 miles of shoreline, and has an average depth of 175 feet.

(d) When and how was the Bay created?

It was created about 10,000 years ago when glaciers melted and sea level rose, flooding the Susquehanna River Valley from near the mouths of the Northeast and Elk Rivers to the Atlantic Ocean.

(e) Where is the Chesapeake Bay located?

The Chesapeake Bay runs north from Norfolk, Virginia to the northeast corner of Cecil County (Maryland) and divides the state of Maryland into two parts.

(f) What are the major cities and rivers located in the Bay region?

The largest cities include: Baltimore, Washington, D.C., Richmond, Hampton Roads, and Norfolk. Major rivers include: the Susquehanna, Patuxent, Potomac, Rappahannock, York, and James on the Western shore of the Chesapeake Bay; and the Elk, Chester, Choptank, and Nanticoke on the Eastern Shore.

(g) What plants, animals, birds, fish, and seafood would you expect to find in the Chesapeake Bay region?

Plants include: numerous marsh grasses in both freshwater and saltmarsh, including spartina, cattails, reeds, marsh elders, water lilies, plantains, numerous shrubs and brambles; vines including grape, honeysuckle, and Virginia creeper; and hardwoods, including sweetgum, cherries, dogwoods, poplars, sycamores, oaks, maples, willows, and hollies.

Animals include: beaver, muskrat, nutria, rabbit, fox, squirrel, opossum, raccoon, snakes, turtles, frogs, and numerous insects.

Fish and seafood include: spot, blue, flounder, rock, silversides, and many other species; crabs, clams, and oysters.

Birds include: various ducks, geese, seagulls, egrets, herons, and many other species of land and waterfowl.

(h) How is the Bay important to us?

For recreation, food, transportation, development, industry, jobs, scientific research, and agricultural irrigation.

(i) What are some of the problems with the Chesapeake Bay?

Erosion, siltation, chemical pollution, and sewage pollution.

(j) Are these problems natural or are they caused by humans?

Some erosion and siltation is natural; many of the problems are caused by human activity.

Lesson 2: Present the slide/tape "the Chesapeake Bay: What It Is to You."

This presentation is in two parts. Part I visually presents: (1) a definition of an estuary; (2) the environmental setting of the Chesapeake Bay; (3) the formation of the Chesapeake Bay; (4) water sources of the Bay; and (5) biota and food webs associated with the Bay.

Part II examines how people benefit from the Bay, including: (1) how humans use the Bay; (2) economic contributions derived from the Bay; and (3) the need for Bay management and conservation practices.

The teacher may select either one or both parts of the slide/tape depending upon the objectives and needs of the students.

Purpose

To visually present the Chesapeake Bay's environmental setting and human uses of the Bay.

Materials

1. Slide/tape set "The Chesapeake Bay: What It Is to You"
2. slide trays
3. slide projector
4. cassette tape player

Procedure

1. Preview the slide/tape to familiarize yourself with its content. The script is found in Appendix B.

2. Prepare the students by explaining the purpose of the presentation, which is to examine the Chesapeake Bay as a natural system and to look at the ways humans interact with it. The teacher may wish to ask the following questions before and/or after the slide/tape presentation:

(a) What is an estuary?

It is a semi-enclosed coastal body of water that has free connection with the open sea.

(b) How are estuarine waters formed?

By the mixing of seawater with the fresh water of rivers.

(c) Name five sources of Bay pollution.

Pollution may result from: (1) agricultural practices; (2) industrial practices; (3) development; (4) waste treatment; or (5) recreational practices.

(d) Describe how the Bay was formed.

When the glaciers melted about 10,000 years ago, the Susquehanna River Valley flooded and caused the sea level to rise about 200 feet. This flooding formed the Chesapeake Bay estuary.

(e) Which rivers supply most of the fresh water to the Bay?

The Susquehanna, Potomac, and the James. Other rivers include the Elk, Chester, Choptank, Nanticoke, Pocomoke on the Eastern Shore; and the Patuxent, Rappahannock, and York on the western side of the Bay.

(f) Describe a food chain beginning with phytoplankton in the Chesapeake Bay.

(1) Phytoplankton; (2) small filter feeder fish; (3) large predator fish; (4) man

(g) List and describe five uses of the Chesapeake Bay.

(1) Transportation; for example, ocean vessels going to and from the Port of Baltimore; (2) recreation; for example, fishing, swimming, sailing, water skiing, camping, and picnicking; (3) industry; for example, waste disposal, and cooling water for electrical generating plants; (4) food; for example, commercial and recreational fishing and harvesting; (5) domestic waste disposal; for example, treated sewage is released into the Bay.

(h) What causes siltation in the Bay?

(1) Water from the land carries silt and deposits it in the Bay; (2) removal of vegetation near the shore can increase natural erosion.

(i) Describe two impacts of agriculture practices on the Bay.

(1) Erosion from disturbed soil surfaces ends up in the Bay; (2) pesticide and herbicide chemicals pollute the Bay.

(j) Describe ways people benefit from the Bay.

Recreation, transportation, water supply, food, sewage disposal, home sites, and employment.

(k) Describe animals' benefits from the Bay.

Food and habitat.

(l) Why is it important to manage the Bay?

Without careful management and maintenance of the natural balance in the Bay the waters will become highly polluted, endangering the ecosystem. We must manage the Bay to ensure that the natural balance is not destroyed through our chemical, organic, and silt wastes.

(m) Define the following terms. (These definitions are found in the *Chesapeake Bay Data Bank* glossary.)

biomass
detritus
ecosystem
estuary
food chain
food web
phytoplankton
pollution
sewage
siltation
tributaries
zooplankton

Lesson 3: Land-use patterns of the Chesapeake Bay Region map studies

Purpose

1. To enable students to interpret water-related and land-use maps of the Chesapeake Bay region.

2. To familiarize students with the correct regional patterns in the Chesapeake Bay area as tools for understanding the location of important activities in the Bay region and the impact of these activities on the Bay.

Materials

"Generalized Land-Use Patterns of the Chesapeake Bay Region, 1970." Unlabelled Chesapeake Bay Map, 8½ × 11". This may be duplicated and used as a worksheet or as a test for the students to illustrate important aspects of the Bay region and human impact on the Bay.

Procedure

1. The teacher should discuss the color-coded legends of the maps.

2. The students should be able to answer the following questions in order to meet the objectives for this lesson:

(a) Identify the states that make up the Bay region.

Maryland, Virginia, Pennsylvania, and Delaware. Waters from parts of New York and West Virginia also flow into the Bay and affect water quality.

(b) Identify the rivers supplying fresh water to the Bay.

Susquehanna, Patapsco, Patuxent, Potomac, Rappahannock, York, James, Elk, Chester, Choptank, Nanticoke, and Pocomoke. (**Note:** The teacher may wish to print in names of rivers not included on the maps.)

(c) Locate the major river valley that formed the main body of the Chesapeake Bay. How was the Bay formed from this river?

Susquehanna. The Bay was formed from melting glaciers about 10,000 years ago, causing the river valley to flood and form the present Chesapeake Bay.

(d) Determine two routes for oceangoing vessels entering and leaving the Bay.

Oceangoing vessels enter the Bay through the channels over the Bay Bridge-Tunnel near Norfolk, Virginia, or through the Chesapeake and Delaware Canal, which connects the Delaware River and the Elk River on the Chesapeake Bay. Ports include Baltimore, Hampton–Newport News, and Norfolk.

(e) Locate Bay wetlands and discuss their importance.

The **blue** areas on the map indicate the wetlands. They are important for habitat, spawning, feeding grounds, and food production for many species of waterfowl, fish, and mammals.

(f) Locate and name the major urban areas of the map.

These are indicated by the **red** areas on the map: Baltimore, Washington, D.C., Richmond, Hampton–Newport News, Norfolk, Annapolis, and Wilmington.

(g) What is an anadromous spawning area?

An area where anadromous fish go to spawn during the late winter and early spring. (Anadromous fish are those species of fish that leave the ocean waters to swim upstream to fresh water in order to spawn.)

(h) What makes the anadromous spawning areas suitable?

The low salinity in these areas provides a more suitable environment for spawning and for the immature stages of fish that need fresh water at the beginning of their life cycles and later require salt water for the mature stages of their life cycles.

(i) How are electric power plants depicted on these maps?

They are depicted by small black squares.

(j) What are some possible environmental impacts of electric power plants on the Chesapeake Bay, and what changes in the environment could they produce?

Power plants withdraw cool water and return water of higher temperature into the Bay, which can affect the growth of plants and animals in the waters near these power plants.

(k) How many sewage facilities are close to the city nearest you?

Look for small round markings on the map and count those in your city.

(l) Can these sewage facilities affect the Bay?

Effluent dumped into the Bay, even after sewage treatment, pollutes the water with excessive nutrients, heavy metals, and chemicals.

Lesson 4: "Chesapeake Bay Fact Sheet"

Purpose

To present an overview of the natural, economic, and social aspects of the Chesapeake Bay region.

Materials

"Chesapeake Bay Fact Sheet" found in the student materials.

Procedure

1. Assign the students to read the "Chesapeake Bay Fact Sheet" and have them answer the questions found at the end of the Fact Sheet. This fact sheet was adapted from the U.S. Army Corps of Engineers *Chesapeake Bay: Future Conditions Report.*

2. Review with the students the answers to the questions. Review the definitions. Some possible answers for the questions are provided below.

Study Guide Questions for
"Chesapeake Bay Fact Sheet"

(a) How does the population of the Bay region in 1970 compare with the projected population as of 2020?

The population is expected to more than double from 7.9 to 16.3 million people.

(b) What other factors are expected to increase as the population of the region grows?

Demand for employment, development, industry, electricity, water supply, boating, ports, transportation, hunting, bird watching, and other factors.

(c) What is the approximate size of the Chesapeake Bay? How does the Chesapeake compare with other estuaries?

The Chesapeake Bay surface area is over 4,400 square miles, it is about 200 miles long, 4-30 miles wide, with over 7,000 miles of shoreline, an average depth of 28 feet with a maximum depth of 175 feet. The Chesapeake Bay is one of the largest estuaries in the world.

(d) Describe how some land uses will change by the year 2020.

The amount of land used for housing will double. The amount of land used for industry will increase one and a half times. The amount of land used for farm land will decrease by 22%.

(e) What may be the water supply situation in the future?

There may not be a sufficient water supply available to serve the demands of the population. It is questionable whether or not new sources of water can be developed without placing too much stress on the Bay.

(f) Discuss the future industrial and agricultural water supply situation.

Due to increased recycling, industry will require modest increases in water consumption. Agricultural water use will increase four times, with 90% of the increase due to increased demand on irrigation.

(g) What factors influence water quality and where are the major problems located?

Factors include: (1) proximity of urban areas; (2) type and extent of industrial and agricultural activity; (3) stream flow characteristics; and (4) amount and type of upstream land and water usage. Most of the problems occur in the estuaries of the tributaries.

(h) What recreational activities will increase in the future?

Boating and sailing will increase more than five times. Swimming will increase four and one-half times. Camping will increase nearly six times. There will be sufficient facilities to meet the demands for the region, but deficiencies may occur in urban areas.

(i) What bulk commodities dominate trade in the ports of Baltimore and Hampton Roads? How will this change by the year 2020?

Petroleum, coal, grain, and iron ore dominate waterborne commerce. Bulk oil is expected to double. Both the increased size of bulk cargo ships and increases in the amount of traffic constitute the need for deepened shipping channels.

(j) Why is oil tanker traffic on the Bay of great concern?

Oil tankers have the potential for oil spills, which would be severely damaging to the Bay environment.

(k) If a 100-year tidal flood occurred on the Bay, what would happen to the surrounding areas?

20,000 acres, including 31 communities, would be endangered.

(l) How much of the Bay's shoreline has a "critical" erosion problem?

410 miles have been identified as having critical erosion problems, based on intensity of development and existing rate of erosion.

(m) What is meant by the term "maximum sustained yield" (MSY)? How is present harvesting of finfish and shellfish affecting the MSY of the future?

MSY is the greatest quantity of a resource harvested without decreasing subsequent harvests. The MSY of many species is projected to be exceeded by the year 2000 due to today's harvesting. Oysters, clams, menhaden, and alewife will exceed sustainable yields by 2020.

(n) What is the primary type of hunting now taking place around the Chesapeake Bay? How will hunting patterns change by 2020?

Waterfowl hunting. Waterfowl hunting will increase 70%, game hunting will increase by 141%, and small game hunting will decrease by 13%.

(o) How much will the demand for electricity increase by the year 2020? How much of a role may nuclear power play in meeting this demand?

Approximately 13.5 times the present demand for electricity will be needed by 2020. Nuclear power may provide 72% of electricity generated by 2020.

(p) What is happening to the aquatic plants in the Bay? How do scientists account for this change?

Aquatic plants are decreasing. It has not yet been determined why the decrease has occurred, but the problem is presently being intensely studied. Possible causes being investigated include chlorine from sewage treatment plants and the runoff of agricultural herbicides.

APPENDIX K

Applications to Local Environmental Issues

Purpose

To give students the opportunity to apply the experience of the BIG Conference simulation to the study of local environmental issues.

Materials

Local newspapers, magazines, and other sources of information concerning local environmental issues. (See Bibliography for an extensive selection of periodicals.)

Procedure

The simulation experience should be followed up with applications to local problems. Some approaches are outlined below.

1. The Maryland's Chesapeake Bay 1984 Initiatives Program (outlined in Appendix I) should be reviewed in terms of its impact on the local environment. An interaction with local governmental agencies and other interested parties in the community would provide a valid perspective of the possible ecological, economic, and social "gains" and "losses" for the immediate area. It would prove quite useful to invite the local delegate to the Maryland General Assembly to share his/her viewpoints concerning the Initiatives.

Another activity that might develop student insights would be the development and administration of a survey that measures local perspective on each initiative.

2. Students should review local newspapers, magazines, television, radio broadcasts as well as their own experience in order to identify specific environmental issues in their area. Examples of local issues which might be identified include: *(a)* littering; *(b)* water pollution; *(c)* use of fertilizers; *(d)* flood-prone areas; *(e)* erosion; *(f)* land-use patterns; *(g)* recycling; *(h)* sewage treatment; *(i)* solid waste disposal—landfills; *(j)* air pollution; *(k)* mass transportation; *(l)* open space areas; *(m)* energy conservation

The class should select one of its local issues for an in-depth study. The study should include researching the issue using a variety of data sources such as reports from local government agencies, newsletters from citizen groups, interviews with or presentations by knowledgeable individuals from a local university and from the business community, minutes from hearings on the issue, etc. The quantity and quality of data gathered will depend upon the issue, the resourcefulness of the class, and the amount of time available for the research. Once the issue has been well defined, the class should develop a set of reasonable public policy alternatives which deal with the issue. It is important for students to assess the environmental impact of the policy alternatives by preparing an environmental impact statement (EIS). Policies should be constructed so as to mitigate their negative impacts. Both the policies and EIS's should be thoroughly discussed and debated by the class. The class should vote on the acceptability of each public policy statement. Whenever necessary a compromise should be reached so that the policy is acceptable to the majority of students in the class. the class should then communicate the results of their decision-making process to local officials involved with the issue.

3. A different approach to local applications involves the identification of people in the community who represent different points of view concerning the issue. Each student should select and research the concerns of one of the identified individuals, resulting in a set of role descriptions. With the teacher's guidance, interest groups should then be formed and a simulation could be conducted similar to the BIG Conference simulation. The procedures and rules should be determined by the teacher in conjunction with the class. Through the simulation, an acceptable public policy should be determined and a report prepared in a fashion similar to the BIG Conference simulation reports. The students should then send the report to the local government officials concerned with the issue for review and invite the officials to class to discuss the policy including problems of implementation. The resulting dialogue between the class and the officials should enhance the students' understanding of the local environmental issue and of approaches to its resolution.

4. A third approach to local application of simulation-derived skills involves student attendance at the state legislature while the local environmental issue is under consideration and debate. The student should then report to the class the following:

(a) Specific aspects of the debate and actions taken during the legislature session.

(b) The views of the local elected officials on the issue.

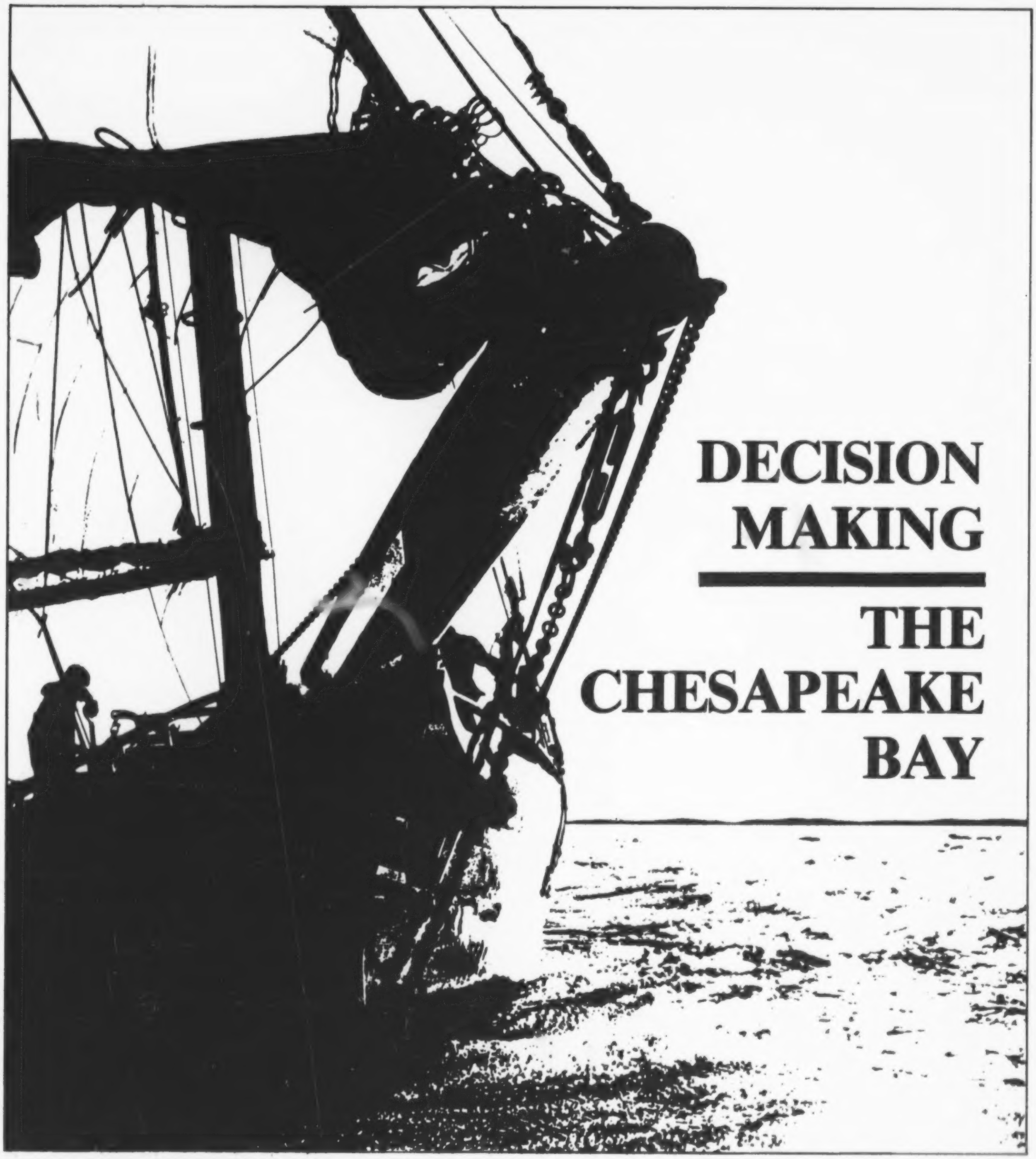
(c) Various citizen viewpoints and public-policy alternatives proposed. The class should continue to follow the issue through news articles, documentaries, etc., which further detail the issue in question.

5. Other activites individual students might use to study local issues:

(a) Research local government procedures including visits to meetings to study how issues are addressed.

(b) Determine channels through which various decisions are made in order to understand actual decision-making processes.

STUDENT MATERIALS



DECISION MAKING

THE CHESAPEAKE BAY

CHESAPEAKE BAY FACT SHEET

Adapted from the U.S. Army Corps of Engineers' Chesapeake Bay: Future Conditions Report

The Chesapeake Bay is a vast natural, economic, and social resource. Along with its tributaries, the Bay provides a transportation network on which much of the economic development of the Chesapeake Bay region has been based. The Bay area provides a wide variety of water-oriented recreational opportunities such as boating and fishing, a home for numerous fish and wildlife, a source of water supply for communities and industries, and is the site for the disposal of many of our waste products. The Bay's natural resources, biological processes, and human activities form a complete system. Unfortunately, problems arise when people's intended uses of one resource conflict with the natural environment, the use of another resource, or a different use of the same resource. Planning is needed to provide efficient use of the Bay's resources.

Today, over 12.7 million people live in the Chesapeake Bay region. By the year 2020, the **population** is expected to reach a level of approximately 16.3 million persons. Employment is projected to grow at approximately the same rate as the population; per capita income (income per person) is projected to nearly quadruple; and manufacturing output is expected to increase by nearly 600%. Thus the Chesapeake region is a rapidly growing area where increases in population, per capita income, and manufacturing will place additional demands on the Chesapeake Bay's waters and related land resources.

The Chesapeake Bay is one of the largest estuaries in the world, with a surface **area** of about 4,400 square miles, a length of nearly 200 miles, and more than 7,000 miles of shoreline. Like many coastal plain estuaries, the Bay is a broad, shallow expanse of water that varies from 4 to 30 miles in width, but has an average depth of less than 28 feet. Its maximum depth is 175 feet near Bloody Point, Maryland.

The marshes, woodlands, and the Bay itself provide an extremely productive **natural habitat** for over 2,700 species of wildlife. The number of species alone indicates the complex nature of the biota around the Bay. These species make up many communities and interrelationships in the Bay ecosystem.

There are many areas in the region that are of significant **historical, archeological,** or **ecological** interest. These include nearly 800 properties that either are included in the *National Register of Historic Places* or have been nominated for that distinction; 20 properties designated as National Wildlife Refuges or Research Centers; and numerous recorded archeological sites.

The **land** needed for residential or housing purposes will approximately have doubled between 1970 and 2020. The amount of land needed for industrial purposes will increase by about 50% if industry is to meet the projected increases in manufacturing output. However, the land in crops and other farmland is expected to decrease by approximately 22%. Although there is enough land in the Bay region available for residential land and industrial development, conflicts over which areas are best for each activity are expected to continue to be a problem in the future.

There are currently 49 central **water-supply** systems in the Bay region that serve 2,500 or more people. In 1970 these systems served about 76% of the people in the region as well as many industries, providing a total of 872 million gallons of water per day. By the year 2020, 31 of the present water-supply systems are expected to have an average water demand that exceeds present capacity. It is questionable whether or not new sources of water can be developed without placing undue stresses on the Bay system.

If we assume that large amounts of water can be recycled, water intake by all Bay-region industry (that is, centrally supplied and self-supplied) is probably going to experience only small increases of about 13%. Water consumption is expected to increase by nearly 800% over this same period.

Total agricultural water demand, used for livestock and poultry, irrigation, and the rural domestic population, is expected to quadruple by 2020, with more than 90% of the increase due to a rise in the demand for irrigation water. However, those areas of the Bay region with large projected increases in available supplies will probably supply enough to meet the future demand.

Water quality conditions in the Bay and its tributaries vary widely due to many factors; for example, closeness of urban areas, type and extent of industrial and agricultural activity, stream-flow characteristics, and the amount and type of upstream land and water usage. As well as toxic chemicals, the Bay also has too many nutrients.

Based on the damage that could be expected from a 100-year **tidal flood**, the tidal flooding problem is considered to be "critical" in 31 communities in the Bay region. An additional 20,000 acres of land within the 100-year tidal flood plain has been proposed for future intensive development.

Approximately 410 miles of Chesapeake Bay shoreline have been identified as having "critical" **erosion** problems, based on the growing development and the existing rate of erosion. Over the last 100 years, approximately 25,000 acres of Maryland shoreline and 20,000 acres of Virginia shoreline have eroded. An additional 44.4 miles of shoreline have the potential to erode in the future.

In the major **ports** of Baltimore, Maryland and Hampton Roads, Virginia, the movement of such bulk commodities as petroleum, coal, grain, and—in the case of Baltimore—iron ore is expeced to continue to dominate water trade. Bulk oil traffic is expected to approximately double by the year 2020 in Baltimore and remain at about the 1973 level throughout the projection period in Hampton Roads. The growing size of bulk tankers, along with the projected increase in traffic, will require deeper channels in the major harbors of the region. Foreign general cargo traffic is projected to increase by approximately six times in both Baltimore and Hampton Roads between 1972 and 2020.

Bulk oil is projected to continue to dominate traffic through the minor ports and waterways around the Chesapeake Bay. The largest increases are expected on the Western Shore due to the larger population and income predicted for these areas as compared to the Eastern Shore. The amount of petroleum traffic is critical because of the possibility of damaging oil spills.

Boating and sailing activity is projected to increase by more than five times, swimming by nearly four and one-half, and camping by almost six times. As a result of this growth, the number of boating ramps, picnic tables, and camping sites must be increased by the year 2020. Total regional swimming pool and beach acreage is considered sufficient to meet demands through 2020 although there are not enough nearby beaches for most of the major urban areas.

Energy conservation programs and higher fuel costs have slowed the rate of growth of Maryland's **energy** demands. Still, existing plants will need to be expanded and new plants built to meet the energy requirements of the state by the year 2020.

"Acid rain," nuclear power, localized effects of power plant operation, energy conservation, and the cost of electricity are major concerns in meeting energy demands.

In 1973, the harvest of **finfish and shellfish** from the Chesapeake Bay and its tributaries totaled 565 million pounds, valued at approximately $47.9 million at the dock. In 1975, planners projected that by the year 2000, when the combined recreational and commercial catches are taken into account, maximum sustainable yields (that is, the greatest harvest that can be taken from a population without affecting subsequent harvests) are expected to have been surpassed for blue crab, spot, striped bass, white perch, shad, weakfish, flounder, and the American eel. Already bans have been placed on catching shad and striped bass in Maryland. By 2020, catches of softshell clams, menhaden, and alewife are also expected to have surpassed their maximum sustainable yields. Because of heavy fishing and natural problems the oyster harvest has seen several sharp declines.

Waterfowl hunting in the Chesapeake Bay region is predicted to increase by 70% by 2020. Big game hunting projections indicate a 141% increase, while small game hunting is expected to decrease by about 13%. This increase in waterfowl and big game hunting will require more access to hunting land.

The demand for **nonconsumptive wildlife uses** including bird watching, wildlife photography, and nature walking is expected to approximately double over the projection period. As a result of these increases an additional one million acres of public land will be required to maintain the quality level that existed in 1970.

Aquatic plants are vital elements of the Chesapeake Bay ecosystem and form the basis in the food chain for the Bay's productive fish and wildlife. Since the late 1960s, submerged aquatic vegetation has declined in abundance and diversity throughout the Bay. The decline is most dramatic in the upper Bay and western shore tributaries.

In the upper Bay, an increasing number of blue-green algal or dinoflagellate blooms has been observed in recent years. In fact, cell counts have increased approximately 250-fold since the 1950s. In contrast, the algal populations in the upper Potomac River have recently become more diverse, with the massive blue-green algal blooms generally disappearing since nutrient controls were imposed in the 1960s and early 1970s in this segment of the Bay watershed.

Glossary

Aquatic—growing in or living in water

Biota—the living components of the ecosystem

Ecosystem—the interactions of living organisms and the nonliving world, producing a functioning unit in nature

Estuary—a semienclosed coastal body of water which has a free connection to the sea—where salt water and fresh water combine

Food chain—an arrangement of organisms in a habitat indicating the food sources for each organism and their interrelationships

Habitat—the place or type of place where a plant or animal normally lives

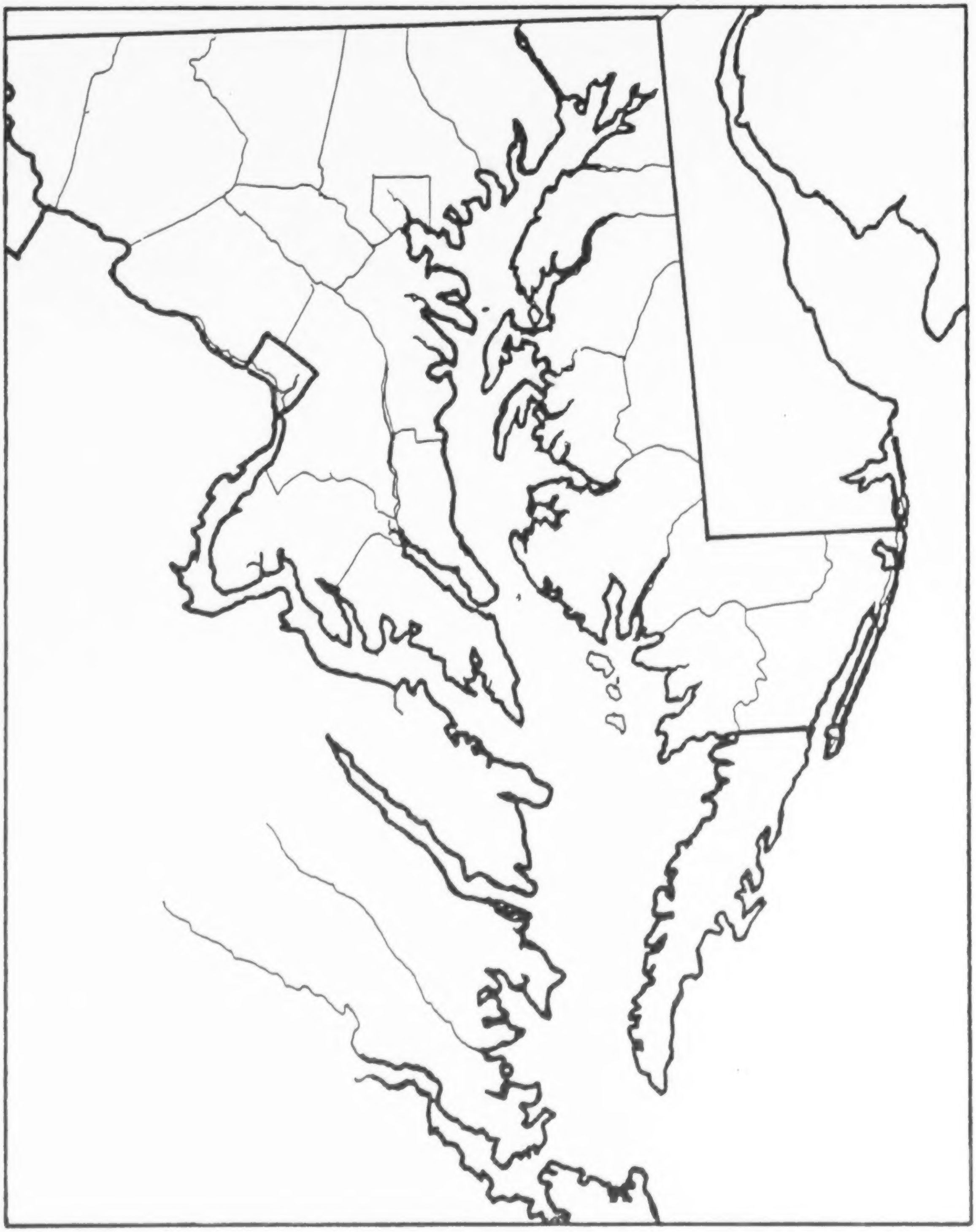
Noxious—harmful to health or habitat

Species—a group of organisms which are alike, having common characteristics and disignated by a common name, e.g., species of *deer*

Tributary—a stream feeding into a larger stream or body of water

100-year tidal flood plain—land area where flooding occurs, on the average, every one hundred years

Unlabelled Map
of the Chesapeake Bay Region



BIG
Bay Interest Groups
11495 Eve Street
Annapolis, Maryland
21404

Dear Delegate:

The State of Maryland Department of Natural Resources has requested our group to recommend Chesapeake Bay Management Policy on Bay issues which we will identify as critical concerns. To prepare a response to the Department's request we are planning a conference at Camp Wilcox, located north of Baltimore, Maryland. You have been selected to represent your organization to ensure that all concerns are represented. It is important that you attend this conference.

The schedule is as follows:

1. Meet with other delegates with similar concerns to identify common interests. (See BIG Conference Delegate Roster)
2. Negotiate and select the four most critical Chesapeake Bay area issues.
3. Determine public policy options for each issue.
4. Specify the possible effects of these policies on the environment and people of the Bay area.
5. Prepare a formal set of policies and recommendations for the Maryland State Department of Natural Resources including the environmental impact of each policy.

I hope that this note gives you sufficient time to plan to attend the Conference. A map and directions to Camp Wilcox will be mailed to you approximately a week before the session. I am looking forward to seeing you or your designee. Please feel free to call with any related questions or concerns.

Sincerely,

A. Sydenham

A. Sydenham
Conference Chairperson
Bay Interest Groups

BIG Delegate Roster

Wetlanders Interest Group

1. *Maryland Shellfishers' Association*
   G. Bradley
   Tylerton, Maryland
   Smith Island 21866

2. *Chesapeake Commercial Finfishing*
   B. Sturgeone
   303 Fudora Drive
   Annapolis, Maryland 21403

3. *Peninsula Trappers' Association*
   H. Adkins
   R.R. #1
   Cambridge, Maryland 21613

4. *Waterfowl Hunting Guides of Maryland*
   L. Churchill
   Box 890
   Easton, Maryland 21601

5. *Delmarva Clamming Association*
   J. Scott
   Tilghman Island
   Maryland 21671

Environmental Interest Group

1. *Save the Bay Foundation*
   W. Benning, Director
   Old Line Road
   Annapolis, Maryland 21403

2. *Wetlands Preservation*
   S. Crawford
   22000 Eastline Drive
   Baltimore, Maryland 21205

3. *Conservation Committee of the Eastern Shore*
   D. McGowen, M.D.
   Sutters Office Building
   3300 Main Street
   Salisbury, Maryland 21801

4. *Women Voters of the Bay*
   H. Jordan
   R.R. #10
   LaPlata, Maryland 20646

5. *Community Action Group*
   B. Johnson
   Bay Ridge Road
   Annapolis, Maryland 21401

Recreation Interest Group

1. *Chesapeake Bay Yacht Owners' Association*
   E. Whitehead
   35 Blue Cove Lane
   Severna Park, Maryland 21146

2. *Chesapeake Bay Sport Fishermen's League*
   F. Johnson
   2302 Potomac Street
   Baltimore, Maryland 21217

3. *Game Hunters' Association*
   T. Swanson
   323 East Front Street
   Prince Frederick, Maryland 20678

4. *Beach Owners' Association*
   W. Jordan
   Box 300
   Skipton, Maryland 21219

5. *Chesapeake Bay Visitors Association*
   J. Watson
   8803 Sunflower Lane
   Gaithersburg, Maryland 20760

Developers Interest Group

1. *Chesapeake Home Builders' Association*
   T. Gilbert
   1401 Buttonwood Lane
   Davidsonville, Maryland 20135

2. *United Realtors' Association*
   P. Martin
   402 Tangier Court
   Dunkirk, Maryland 20754

3. *Commercial Construction Association*
   R. Heffner
   1784 Blue Bird Lane
   Bel Air, Maryland 21014

4. *Bankers' Association*
   H. Setters
   139 Union Court
   Upper Marlboro, Maryland 20870

5. *Economic Consultants, Inc.*
   F. Lauter
   9210 Main Street
   Mathews, Maryland 20710

Scientific Interest Group

1 . *Disaster Control, Inc.*
W. Stanton, Ph.D., President
Trade Winds Office Building
9743 Henry Street
Bethesda, Maryland 20014

2 . *Water-Quality Scientist*
M. Kirk, Ph.D.
Department of Geology and Hydrology
Johns Hopkins University
Baltimore, Maryland 21214

3 . *Air-Quality Consultant*
M. West
Delmarva Scientific Consultants
18 Denver Street
Ocean City, Maryland 21842

4 . *Fish and Wildlife Biologist*
J. Richardson
University of Maryland Center of Estuarine and Environmental Studies
Cambridge, Maryland 21613

5 . *Marine biologist*
M. Miller, Ph.D.
Associate Professor of Marine Ecology
Botany Department
University of Maryland
College Park, Maryland 20742

Private Interest Group

1 . *Home Owners' Association*
H. Honner
R.R. #7
Annapolis, Maryland 21401

2 . *Double-F Association (Farmers and Foresters)*
P. Ameri
Croom, Maryland 20870

3 . *Small Business Association*
C. Zimmerman
Cambridge, Maryland 21613

4 . *The Sand & Gravel Co.*
H. Shore
Glen Burnie, Maryland 21061

5 . *United Marina Owners' Association*
E. Holloway
Deale, Maryland 20751

Industrial Interest Group

1 . *East Coast Steel*
M. Washburn
Director of Public Relations
East Bank, Maryland 21205

2 . *Metro Steamship Agency*
W. Moskowitz
President and Owner
Baltimore, Maryland 21227

3 . *United Petroleum*
E. Banks
Executive Vice President
Baltimore, Maryland 21227

4 . *Chesapeake Bay Power Co.*
L. Greenburg
Director, Research & Development Division
Annapolis, Maryland 21402

5 . *Harbor & Port Consultants, Inc.*
E. Brown
Director
Baltimore, Maryland 21222

BIG **Bay Interest Groups**

11495 Eve Street
Annapolis, Maryland
21404

MEMORANDUM

TO: Bay Interest Groups (BIG) Conference Delegates

FROM: A. Sydenham,
Conference Chairperson A. Sydenham

RE: BIG Conference Agenda

Session I: Orientation to Task: A. Sydenham

Session II: Meet with Members of your Interest Group.

1. Get acquainted and share personal points of view and interest.
2. Identify concerns common to your interest group.
3. Select, from the Bay issues list, four issues your interest group would like BIG to support and submit to the Maryland Department of Natural Resources. Consult the "Chesapeake Bay Fact Sheet" for supporting arguments. The Chairperson will outline the procedures for selecting four of the twenty Bay issues to be considered.

Session III: Issue Negotiation and Voting.

1. Obtain from Chairperson twelve chips for your interest group.
2. Elect one person to stay at the interest group's table to deal with bargainers from other interest groups and hold the twelve chips.
3. Negotiate, compromise, bargain, or form coalitions with other interest groups to support your selected issues. Consult the "Chesapeake Bay Fact Sheet" for supporting arguments.

4. Before actual voting, meet again with your interest group to determine the placement of the chips.

5. Following the procedure outlined by the Chairperson, cast your ballot for the critical issue(s) identified by your group. Four Bay issues will be selected for further study.

Session IV: Policy Options, Negotiation, and Voting:

1. Meet with interest group and read Memorandum Re: Public Policy Statements for the Selected Issues.

2. With your interest group research the four selected issues in the Chesapeake Bay Data Bank.

3. Four each issue write one public policy which reflects the position of your group.

4. Present your group's public policies to the BIG Conference along with a rationale for each policy.

5. Negotiate, compromise, bargain or form coalitions with other interest groups to gain support for your policies. Modify policies where necessary.

6. Follow the procedure for voting rounds, as outlined in the Memorandum Re: Policy Voting Procedures to select a public policy for each issue.

Session V: Environmental Impact Statement (EIS):

1. Research with your interest group the effects or impact of each selected policy on the environment of the Chesapeake Bay. Consult freely the Chesapeake Bay Data Bank.

2. Complete the EIS grid for each policy with your interest group.

3. Subcommittees (one representative from each interest group) negotiate and complete a synthesized EIS grid for each policy.

4. Submit for discussion and vote on each mitigated policy.

5. Prepare, as a total BIG Conference Group, a short list of specific reasons for the decisions.

Session VI: FINAL REPORT

Prepare a BIG Conference Final Report for submission to the State of Maryland Department of Natural Resources.

BIG Conference Roles–*SCIENTISTS*

DISASTER CONTROL SCIENTIST

W. Stanton Ph.D., president of Disaster Control, Inc., Bethesda, MD. You received your Ph.D. from Florida State University in 1974 in oceanography. Your dissertation focused on effects of oil spills to the salt marshes in your region. You were very interested in the 1975 National Oil and Hazardous Substances Pollution Contingency Plan, which was published by the Council on Environmental Quality. This plan prompted you to come to Washington, D.C., to work on disaster control. You formed your own Disaster Control, Inc., company after working for government agencies in this field for two years. Now the government and industrial agencies contract with your company for consultation concernig oil spills and other hazardous discharges on the Chesapeake Bay. Your company focuses on oil spill response.

Oil spill response has three phases: (1) prespill planning and preparedness; (2) actual response, beginning with the first notice of a spill or potential spill and ending with wildlife protection and cleanup activities; and (3) postspill evaluation and reporting.

Environmentalists have led much public opposition to offshore oil production. However, analysis of 36 major oil spills indicates that tankers, barges, and other vessels are the source of the greatest number of oil spills. Increased oil importation and traffic congestion in ports have increased the likelihood of accidents, groundings, and collisions.

Oil companies have increased the size of their tankers from 18,000 to over 200,000 dead weight tons (DWT). (One DWT is equal to 250 gallons.) These supertankers require over 90 feet of draft (water depth) and cannot come up the Chesapeake Bay because the Bay Bridge Tunnel restricts ships to 45 feet or less.

It is important to remember that even small spills can be very damaging to sensitive areas. Small oil spills could be trapped by salt marshes and released slowly over time to prolong damage over many years.

During your graduate studies you saw the death of all forms of aquatic life from oil spills. Oil is poisonous to most life forms, directly through contact or indirectly through food chains. New technology is needed to help clean up oil spills and restore damaged areas. Even more necessary is research into alternate forms of energy so that oil is no longer a threat to aquatic life. You would like to see all this become part of the policy statement made by the state government. Even though you do consulting with many government offices, you feel there has been insufficient input.

You recently joined an organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). BIG plans a conference in the near future to suggest management policy to the state government. You are excited about attending the conference and working with other scientists in one of the seven divisions of the BIG Conference. You feel that working with water-quality scientists, air-quality scientists, botanists, and fish-and-wildlife scientists will enable you to take a united stand on issues concerning pollution, development, and increased research. It may be difficult to set priorities, but the most difficult aspect of this BIG Conference will be to gain support of other divisions that are not so ecologically-minded.

WATER QUALITY SCIENTIST

M. Kirk, Ph. D., a hydrologist (water scientist) in the department of geology and hydrology at Johns Hopkins University. You grew up on the Eastern Shore of the Chesapeake Bay and have always been interested in all aspects of the Bay environment. With your position as water quality scientist you have consulted with the U. S. Geologic Survey and studied streamflow data of the many rivers that provide fresh water to the Bay. You have seen the effects of natural variation in rainfall—both floods and droughts. The effects of human activities cause you the most concern.

The rivers bring many kinds of pollutants with them as they flow into the Bay. Sediment from agricultural and construction activities clog the channels dredged for commerce. Toxic chemicals from industry and agriculture affect life in the Bay. Both large commercial ships and small pleasure motor boats have a negative impact on the Bay. You estimate that the total effect of boat traffic is the same as a city of 20,000 population, dumping raw sewage into the Chesapeake.

The Bay should still be considered a natural resource; however, as you look at the Bay area's projections of population expansion, you wonder how well we will be able to keep it from becoming an unnatural hazard. Baltimore City and 16 Maryland counties discharge wastewater into the Bay, yet the Bay supplies drinking water, jobs, food, recreation, and transportation for the whole region. Clearly, the water quality of the Chesapeake Bay must be maintained by coordinated effort of all who benefit from it. Coordinating all of the many conflicting interests in the Chesapeake Region is a huge job.

You have been going to the State Department of Natural Resources to investigate and present input into the new policies being developed and administered for the Bay. While there, a colleague suggested that you join an organization called Bay Interest Groups which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). BIG is having a conference, soon to be scheduled, that is made up of seven divisions. Your division, the scientist division, also includes an air-quality scientist, a fish-and-wildlife scientist, a disaster-control scientist, and a botanist.

You are currently planning your own stand on many issues. You are collecting data in preparation for the BIG Conference. You plan to concentrate on the issues of limiting fertilizer and herbicides, lowering the amount of industrial waste entering the Bay, and demanding tighter controls on sewage treatment plants. You also want to point out the effects of thermal pollution by power plants and find answers to the control of sediment from construction and agricultural development. This collection of data is quite important, because many diverse viewpoints will be represented at the BIG Conference.

AIR-QUALITY SCIENTIST

M. West: as an air-quality consultant to industry and government in the Washington D.C. and Baltimore areas representing the Delmarva Scientific Consultants, your job is to analyze potential air-pollution levels from new industrial facilities and recommend equipment to minimize their impact: You recognize that air quality is not a local problem, and you have contributed studies that show that polluted air from the Midwest has great impact here on the East Coast.

In the Washington, D.C. and Baltimore areas, automobile traffic is the primary source of locally produced air pollution. Plans to encourage mass transit, such as buses and subways, are very important if the air is to be improved. Gasoline prices, parking fees, and parking bans will help bring about public acceptance of mass transit. Simultaneous development of transit systems is also necessary.

Your studies also show coal- and oil-burning power plants and factories are dangerous to air quality. Expensive equipment can be added to cleanse the air coming from such facilities. Human health is well worth the expense needed to maintain it. Other data from your studies show the decline in human health that occurs in polluted environments. Whenever people complain about the price of maintaining air quality, you show them the alternative cost of endangering human lives.

You have grown very attached to the Chesapeake Bay region, as your work frequently brings you to the Bay area. You wish to see the air quality improved here.

You belong to an organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland state Department of Natural Resources. BIG is having a conference where each of its seven divisions will send representatives to propose management policies to the Department of Natural Resources. Your division is made up entirely of scientists who represent the people concerned with the Bay environment. As an air-quality scientist you support the endeavors of your fellow scientists: a water-quality scientist, a disaster-control scientist, a fish-and-wildlife scientist, and a botanist. You will take a stand on many of the issues that are important to the continued survival of the Chesapeake Bay area. Much research is required, but you will support a slower rate of industrial development, less development of the wilderness areas (usually the wetlands), and a decrease in the levels of pollutants coming into the bay area in both the air and the water. These positions will be consistent with the others in your division, but will undoubtedly be opposed by members of the other divisions.

FISH-AND-WILDLIFE SCIENTIST

J. Richardson: a fish-and-wildlife scientist from the University of Maryland Center of Estuarine and Environmental Studies. You are currently studying the life cycle of the blue crab, which spawns in the lower Chesapeake Bay and moves up into the lower-salinity waters as it matures. You have found that an average of 75,000,000 pounds of blue crabs are harvested each year commercially, and an unknown but large amount is harvested by recreational crabbers.

The large harvest each year is an encouraging indication to you of the Chesapeake Bay's productive ecosystem. As you watch crabs feed on detritus, phytoplankton, and bacteria you see crabs capture the productivity of this estuary, which produces a valuable economic and food resource for humans.

You encourage cooperation by crabbers in harvesting legal-sized crabs—those five inches or more across. You also believe that harm may be done by capturing female egg-bearing crabs. You would like to see sport crabbers, as well as commercial crabbers limit the numbers of their crab catches in order to ensure current production levels of crab yeilds for the future.

As food needs increase with the growing world population, you believe the importance of estuary ecosystems will grow. Aquaculture (farming the sea or other aquatic systems) is a future resource deserving careful attention. In order to accomplish this, you feel that some changes are required at the present time. Although your research findings are reported to the government, you have felt that this alone has not been effective in changing policy. You wish to help change Bay management policy to insure future crab production.

You recently joined an organization called Bay Interest Groups (BIG) which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). BIG will soon have a conference. Your division, the scientist division, also includes a botanist, a water-quality scientist, an air-quality scientist, and a disaster-control scientist. You are a unified group; however, there are six other divisions represented at the BIG Conference — all of which will not entirely agree with your group to present a unified policy. This is an ideal opportunity for you to propound some policy options you feel are necessary to continued productivity of the Bay region. Some of your concerns are lower quotas for commercial fisherman, slowing the rate of development of wetland marshes, lowering the level of pollutants in the Bay waters, and further research in aquaculture. If any one policy covering any of these concerns is presented to the Department of Natural Resources, you will consider your efforts to have been successful.

BOTANIST

M. Miller, an associate professor of marine ecology in the botany department at the University of Maryland, specializing in salt-marsh and estuarine vegetation. You grew up in San Francisco, and while a teenager you helped to save the marshes of the San Francisco Bay. You like to remind people that salt marshes are the most productive ecosystems on earth.

You came to Maryland to help research dying aquatic vegetation in the Chesapeake Bay. You believe that agricultural herbicides, industrial wastes, and sedimentation are causing these aquatic plants to die. Your major concern is that this decline in submerged vegetation may indicate serious problems in the Bay's ecosystem.

This is only one example of the many interrelated problems in the Bay area. There are many endangered plants in the water and on the shore, especially in the marsh or wetland areas. You feel that many changes are required to solve the growing number of problems with vegetation. Traffic on the Bay needs to be decreased and there should be fewer pollutants entering the Bay water. You see the following needs: (1) limit the use of fertilizers and herbicides; (2) lower the amount of industrial waste put into the Bay; (3) control sewage-treatment effluent more effectively; and (4) reduce sources of sediment runoff into the Bay.

Your concerns persuaded you to join an organization called Bay Interest Groups (BIG) which sreves in an advisory capacity to the Maryland State Department of Natural Resources. Your scientist division is one of seven divisions that will be represented at a BIG Conference. A fish-and-wildlife scientist, a water-quality scientist, an air-quality scientist, and a disaster-control scientist will work with you in your division at the conference. While there is usually agreement on issues between members of your division some of the other divisions often have difficulty in seeing your viewpoints. These groups may feel that scientists take matters far too seriously. You are prepared for this reaction at the BIG Conference and have collected facts on many Bay issues before the conference will convene.

BIG Conference Roles–WETLANDERS

MARYLAND SHELLFISHERS' ASSOCIATION

G. Bradley: Your family has been in the business of harvesting oysters and crabs from the Chesapeake Bay for 200 years. You are married and have three children. In 1962 you graduated from Crisfield High School, followed by a two-year stretch in the U.S. Army. After that, you lived in Annapolis for three years working for a building contractor. You then moved back to Smith Island in 1967 to take over the boat for your retiring father. You know that this is the life for you and your family. You rarely leave the Smith Island area.

Crabbing and oystering is not like it used to be. The second year in a row hard winters have greatly reduced the crab population. Oysters have not fully recovered from Hurricane Agnes (1972). With severe restrictions on limits and legal birds, duck hunting is greatly reduced. Even though you see thousands of them around the Island, redhead ducks cannot be hunted without a fine and possible jail sentence. You and other watermen are not sure why the hunting has been so severely curbed. The Maryland Shellfishers' Association holds a lot of resentment toward the fish and game people from the Department of Natural Resources. You feel that outsiders should not interfere with the independence that has been the way of Maryland watermen for over 300 years.

To help protect your interests, you joined the Maryland Shellfishers' Association in 1973. This organization has the following concerns:

1. Fairer laws for shellfishers at the local, state, and federal government levels—i.e., making sure that watermen receive fuel and gas during the shortages and getting the Coast Guart to reopen the Bay after it freezes over.
2. Supporting efforts to create larger and better harvests by controlling pollution. This organization sees Baltimore and industrial wastes as a major pollution problem along with continued development of shore property causing decreased fishery.
3. Increased sport fishing has left fewer fish for commercial fishermen to have their livelihood.

In an effort to promote its concerns more effectively, the Association has joined another larger organization, Bay Interest Groups (BIG) which serves in an advisory capacity to the Maryland State Department of Natural Resources. In your division of BIG you work with members of the Peninsula Trappers' Association, the Finfishing Association, the Waterfowl Hunting Guides of Maryland Association, and the Delmarva Clamming Association. You realize that there are six other divisions of BIG at the Conference—each with their own concerns. You will have to take a stand on various issues. Your role at the BIG Conference is to represent fairly the concerns and interests of the Maryland Shellfishers' Association and lobby for the selection and study of the issues that directly affect shellfisher intersts.

CHEASAPEAKE FINFISHING ASSOCIATION

B. Sturgeone: You have run a fishing boat out of Annapolis for the past ten years. You have found that the rockfish, alewife, blueback, herring, whitefish, shad, and anchovy have decreased in large numbers within the past few years. You are beginning to feel that the increase in bluefish may not be a natural occurrence, but instead, might be attributed to pollution and overuse of the land.

As a commercial finfisherman, your specialities are rock and white perch. You once fished shad heavily, but they have been very scarce in the upper Bay in recent years. Your job is a rugged life, but you enjoy your work. Earnings are in direct proportion to the catch for everyone aboard. To supplement your income, you have a small farm.

You belong to the Chesapeake Commercial Finfishing Association. Your association is concerned with: (1) lobbying for state hatcheries to replace the missing fish; (2) a rapidly growing sport fishing industry; and (3) supporting efforts to maintain clean water throughout all the spawning areas. In order to promote these concerns the Chesapeake Commercial Finfishing Association joined the larger group, Bay Interest Group (BIG), who in turn serve as an advisory group to the Maryland State Department of Natural Resources (DNR) and advise in areas of management policy based on interests and concerns of the members. There are seven divisions of BIG. Within your Wetlander division you also work with members from the Waterfowl Hunting Guides of Maryland Association, the Peninsula Trappers' Association, the Maryland Shellfisher's Association, and the Delmarva Clamming Association.

You realize that the other six divisions have their own concerns. This means that you will have to be well prepared and ready to take a stand.

Your role at the BIG Conference is to represent fairly the concerns and interests of the Chesapeake Commercial Finfishing Association and lobby for the selection and study of the issues that will directly affect future growth of the finfishing industry.

PENINSULA TRAPPERS' ASSOCIATION

H. Adkins: You live near the Choptank River, one mile southwest of Cambridge, Maryland. You received a B.S. in elementary education from Salisbury State in 1964, followed by a M.Ed. in education administration in 1972. Your hobby is fur trapping for muskrat and nutria. You are one of 20,000 Marylanders who take fur pelts. You grew up on the Eastern Shore and spent many memorable years trapping with your father. The pelts you take from the furbearers of the marshes normally find a ready and profitable market. For the last several years, this money has allowed you, your spouse, and your three children to fly to California each Christmas vacation to visit your in-laws. However, you believe that your fur trapping income will be much less this season because: (1) the marshes have been frozen by a hard winter; (2) there is less food and shelter in the marshes than there once was; (3) a new breed of trapper is not leaving enough breeding stock as a result of intensive trapping.

You consider yourself a conservationist and a game manager. You tend to completely disregard the views of people who think that your hobby is "cruel and unusual punishment" to innocent animals, for if they knew more they would understand that the population of "water rats" must be controlled. For example, you know that the rapid reproduction of nutria imported from South America many years ago has had an alarming effect on the plants and root systems in the marshes. Nutria might exceed the carrying capacity and lead to the total destruction of the marshes and increased erosion and siltation. This impact is little, in your opinion, compared to human's land practices, such as housing development, industrial development, and recreational pressure, which have created tremendous problems in maintaining the quality of the Chesapeake Bay.

You joined the Peninsula Trappers' Association three years ago mainly to buy traps and other equipment through the Fur Trappers Coop, which saves you a considerable amount of money each year. In addition, you find the Association's newsletter very useful in learning new techniques for trapping, skinning, and preserving pelts. You have written several articles yourself that have been well received by Association members. This past year the Coop began marketing wholesale lots of hides for members to earn additional cash.

In an effort to promote their concerns more effectively, the Association has joined another larger organization, Bay Interest Groups (BIG), which is an advisor to the Maryland State Department of Natural Resources (DNR) in areas of management policy based on the interests and concerns of the members. You belong to the Wetlanders division of BIG. In addition to the Peninsula Trappers' Association, your division includes members from the Waterfowl Hunting Guides of Maryland Association, the Finfishing Association, the Maryland Shellfishers Association, and the Delmarva Clamming Asociation.

It is your opinion that working within the framework of BIG will greatly help your own organization. Your group has many common interests and concerns with the others in your division. However, the six other divisions of BIG Conference have their own concerns. This means that you will have to take a stand and be able to support it. When contacted by BIG, the Association's president submitted your name as the representative. Your aim is to build a positive image for trappers and to fight for the maintenance of habitats of fur-bearing animals.

WATERFOWL HUNTING GUIDES OF MARYLAND ASSOCIATION

L. Churchill: You are one of Maryland's 130 licensed waterfowl guides and outfitters. You live on the outskirts of Easton, just off U.S. 50, with your spouse and three elementary-school-age children. A large sign in your front yard vividly displays your occupation: "Duck/Goose Hunting Parties - Inquire Within." You have hunters coming from the entire East Coast and as far west as Indiana. Because waterfowl hunting is permitted only during three winter months, you supplement your income with an antique business from a building adjacent to your house.

You are concerned about the way things have changed over the years. You see a great number of geese each year, but you also see major declines in most duck populations. Only mallard and black duck populations seem to be "holding their own." Both geese and the mallard/black ducks depend primarily upon corn, wheat, and soybean fields for food. The water of the Bay and its tributaries is primarily a place to rest and find protection from predators. The diving ducks cannot feed in fields, because they are too slow to take wing from dry land, making them easy prey for predators. Thus, they are dependent on the marshes for food. You are not sure what has led to a decline in the diving ducks, but you think that development of the waterfront for housing and recreation has caused erosion, landfills, and water pollution. You feel that we have had a "people population overkill." In addition, you are concerned about the possibility of an oil spill in the upper Bay, a disaster that could wipe out countless thousands of ducks and geese.

In general, you would like the Bay and its marshes to remain the same without human intervention. You feel change is bad.

To help promote your interests in waterfowl hunting, you and about 75 of your colleagues have banded together to form the Waterfowl Hunting Guides of Maryland Association. You now serve as the organization's president. Initially, your primary interest was promoting waterfowl hunting by publishing an annual booklet listing the names and skills of each guide. Lately, the executive committee has begun to explore ways to help build up the duck population to acceptable numbers by feeding imperiled waterfowl on the Chester River and working with the Maryland Department of Natural Resources to persuade DNR to reestablish habitat areas for diving ducks.

In order to promote these concerns more effectively, the Association has joined another large organization. This group is called Bay Interest Group (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR) in areas of management policy based on the interests and concerns of the members. You belong to the Wetlanders division of BIG.

In addition to the Waterfowl Hunting Guides of Maryland Association, your division includes members from the Finfishing Association, the Peninsula Trapper's Association, the Maryland Shellfishers' Association, and the Delmarva Clamming Association.

Working within the framework of BIG will greatly help your own organization. Your group has many common interests and concerns with the others in your division. There are six other divisions of BIG—each has its own concerns. You must be well prepared to take a stand and be able to support it. Your role at this BIG meeting is to represent fairly the concerns and interests of the waterfowl hunting guides and to lobby for the selection and study of issues that directly affect your interests.

DELMARVA CLAMMING ASSOCIATION

J. Scott: You live on Tilghman Island, Maryland. You are forty-seven years old and have been digging for clams since the age of twenty-one. Business has not been good. Last year's total catch was only about 140,000 bushels compared to catches averaging 500,000 in 1971 and 680,000 bushels in 1964. The clam industry on the Bay is at its lowest ebb since it began in the early 1950s. Shellfish are so scarce that a bushel costs five times as much as a few years ago. There are very few clammers still dredging that were digging when you started. Your recent catches have been so poor that you cannot afford the upkeep of your dredges or even afford helpers. You have seriously considered docking your hydraulic dredgeboat and converting your clam processing business to oysters.

You feel that clam and oyster production would be greatly increased if more effort was spent by the Department of Natural Resources to replant clam and oyster beds. In your opinion the Department of Natural Resources has lost touch with your self-supporting industry and, at your expense, has expanded to accommodate hunters, and forests and parks.

You understand that natural conditions, such as temperatures and salinity, cause clam populations to fluctuate greatly, but you also feel that chemical pollution and siltation caused by human activities have seriously thwarted the clams from recovering to their former yield.

You are a member of the Maryland Shellfishers' Association and have supported this organization over the years. Recently, you and several other clammers have felt that the organization is primarily concerned with the big cash crop, oysters. For that reason you have formed an alliance with fellow clammers from Delaware and Virginia to create a new organization, the Delmarva Clamming Association. Currently, you have been visiting the Department of Interior Fisheries Branch, the Maryland State Department of Natural Resources, and the Sea Grant Office at the University of Maryland to discuss the dilemma of the clamming industry and to solicit their help in solving the problem.

While doing this research, you came across an organization called Bay Interest Group (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR) on management policy based on the interests and concerns of the members. You contacted this group to represent the Delmarva Clamming Association. Your association belongs to the Wetlanders division of BIG. There are seven divisions in all. In your division, you will be working with members of the Peninsula Trappers' Association, the Waterfowl Hunting Guides of Marylane Association, the Finfishing Association, and The Shellfishers' Association.

It is your opinion that working within the framework of BIG will help your own organization. Your role at this BIG conference is to lobby for the selection and study of issues that will help solve the problems of the declining clam population. You realize that there are six other divisions of BIG, and each with its own concerns. You must be prepared to take a stand and be able to support it.

BIG Conference Roles–*ENVIRONMENTALISTS*

SAVE THE BAY FOUNDATION

W. Benning: Director of the Save the Bay Foundation. As a lifelong resident of the Bay region you have grown up regarding the Bay as a friend. You have spent many afternoons walking the sandy shoreline or sailing the quiet, clear waters. In the last ten years, you have watched the slow deterioration of the Bay with growing sadness: the waters are less quiet, the sandy beaches are less clean. This beautiful country has been inundated by people and industries who lack the sense of caring that you possess.

Your deep feeling about the Chesapeake Bay has forced you to devote all your time and energies into establishing the Save the Bay Foundation. It is obvious that the only way to return the Bay to its pristine condition (as you remember it as a child) is to stop the mass movement of people to the region. This can be done by preventing industries from coming to the area, reducing the recreational outlets available, stemming the tourist flow, and making it difficult for new housing to be built. You and your workers at Save the Bay Foundation are trying to achieve these goals but you realize that you cannot do it alone. Consequently, you have banded together with other organizations to form the Environmental Council. The other members are Wetlands Preservation, Inc., Conservation Committee of the Eastern Shore, and Women Voters of the Bay. You hope that as a coordinated group of organizations, the Environmental Council will have a strong influence in protecting and planning for the environmental quality of the Chesapeake Bay. Since your group wishes to return the Bay to a cleaner and more beautiful state, the foundation is the most extreme group in the Environmental Council. The council as a group has adopted the goal of maintaining the current situation in the Bay region. You are in full support of this goal because it must be reached before restoration of areas can begin. You do, however, support any policies that do restore the Bay areas to previously beautiful and natural states.

Joining the Environmental Council was a wise move because there is power in numbers. In order to extend this range of influence, the Environmental Council has recently joined another organization, Bay Interest Groups (BIG) which serves as an advisor to the Maryland State Department of Natural Resources (DNR) and advises on management policy whenever possible. The Environmental Council is one of seven divisions of BIG. Each division consists of groups with similar interests. Your division of BIG is probably the most unified, because they joined as an already established group. Even though there are a number of groups that will differ with your position, you feel confident that your new division will be so well prepared that you will gain the support of other divisions and be influential in policy development.

CONSERVATION COMMITTEE OF THE EASTERN SHORE

Dr. D. McGowen: as a long time resident of the Eastern Shore and Salisbury, you have practiced medicine for thirty-two years. You have a deep affection for the land along the Chesapeake Bay. In recent years, you have practiced less medicine in order to enjoy the slow, peaceful life found in the Bay country. This leisure time has also made you aware of the rapid changes taking place around you: the heavy weekend traffic through Salisbury as cityfolk flee to the beaches; the change in the fresh water of the Bay; talk about an oil refinery down at Crisfield; and the government has authorized the deepening of the river channels to Salisbury, Seaford, and Easton to bring more barges to these ports.

An organization of concerned citizens was founded two years ago to address some of the increasing problems that development and growth were bringing to your area. The group called itself the "Conservation Committee of the Eastern Shore," and you were elected to chair the group. The members of the Conservation Committee feel that growth is good, because it brings money into the economy of the Eastern Shore, but too much of a good thing can be harmful. The Bay environment must be protected from too much growth too soon. Consequently, the Conservation Committee has set as its goal the coordination of growth in the Bay area with sound environmental management.

Too few members have had time to work on the committee. Now, however, you see a chance to really contribute something to solving the problems of the Bay. The Conservation Committee has been asked to join with several other organizations concerned about the ecology and the deterioration of the Bay to form the Environmental Council.

You hope that this coordinated group can have a strong influence in protecting and planning for the environmental quality of the Chesapeake Bay. You take a strict ecological stand on maintaining the current level of Bay quality, although you don't want to eliminate business development completely.

The Environmental Council has recently joined forces with another larger organization, Bay Interest Groups (BIG), which serves as an advisor to the Maryland State Department of Natural Resources on management policy. The Environmental Council is one of seven divisions of the BIG Conference and is probably the most unified, since it joined as an already established group. Even though there are a number of groups that will differ with your position, you feel confident that your division will be well prepared and will gain much support.

WETLANDS PRESERVATION, INCORPORATION

S. Crawford: As a marine biologist from Florida State University, you came to the Chesapeake Bay Region in 1964 to research one of the most productive estuarine breeding grounds in the world. Since coming to this area, however, your interests have shifted to the salt marsh and the important role it plays in the ecology of the area. In 1976 you established your own research company, Wetlands Preservation, Inc. Through this organization, you and your assistants have set as your highest priority the protection and preservation of wetland areas. Your successful research on reestablishing wetlands has gained wide recognition, and your company frequently is hired by Maryland to establish marsh areas to protect state lands from erosion. In addition, Wetlands Preservation, Inc., is active in introducing marsh protection laws in the state legislature and in purchasing marsh lands for preservation.

As a small organization, your company has a limited amount of influence in determining the future of the Chesapeake Bay. Consequently you have banded together with other organizations with similar concerns to form the Environmental Council. The other members are the Save the Bay Foundation, the Conservation Committee of the Eastern Shore, and Women Voters of the Bay. You hope that as a coordinated group, the Environmental Council will have a strong influence in protecting and planning for the environmental quality of the Chesapeake Bay. You intend to take a stand that will preserve the status of the Bay. You will support policy that improves the quality of the Bay, but you will not support policy that endangers the Bay ecosystem.

The Environmental Council, a small group of interest groups concerned about the Bay, has recently joined forces with another larger organization called Bay Interest Group (BIG), which serves as advisors to Maryland State Department of Natural Resources (DNR) in areas of management policy whenever possible. The Environmental Council is one of seven divisions of BIG Conference. Each division is made up of groups with somewhat similar interests to preserve. Your division is probably the most unified of the divisions, because you joined as an already established group, not as individual groups. Even though there are a number of groups that will differ with your position, you feel confident that your division will be well prepared and will be able to develop policy.

WOMEN VOTERS OF THE BAY

H. Jordan: as a long-time resident of southern Maryland you have been active in the Maryland League of Voters since 1968. Since the 1975 oil spill off Calvert Cliffs in the Chesapeake Bay, you have been increasingly aware of the need for environmentally sound legislation to govern growth and industry in the Bay area. In 1976 you helped form a branch of the League of Voters concerned specifically with Bay-related political issues. This branch, Women Voters of the Bay, informs the Bay citizenry of the following:

1. Ecological disturbances on the Bay;
2. Pending Bay legislation at the state and federal level;
3. Problems created in the area by poor industrial planning and too rapid growth;
4. Decrease in the environmental quality of the Bay.

You have felt somewhat frustrated by the lack of progress that the Women Voters group has made, but now see the potential for increasing that influence. Women Voters of the Bay was asked to join the Environmental Council when the council was formed two years ago. The Environmental Council is an organization consisting of several small groups concerned with the uncontrolled growth along the Chesapeake Bay. Through a coordinated effort, the Environmental Council has strongly influenced the formation of policies that will protect the environmental quality of the Chesapeake Bay. Each group of the Environmental Council has taken a united stand on the Bay. They wish to maintain the current level of water quality on the Bay; prevent development of wetland areas; and prevent uncontrolled development of any kind around the Bay. You feel that people who use the Bay for recreation sorely abuse it, and industry is far more interested in making money than in preserving the environment.

Joining the Environmental Council was a wise move for the Women Voters, because the Environmental Council has influence, and also because the Council has recently joined a larger organization, Bay Interest Groups (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR) in areas of management policy. The Environmental Council is one of seven divisions of the BIG Conference. Your division of BIG is probably the most unified since it joined as an already established group. Even though there are a number of groups that will differ with your position, you feel that your new division will be well prepared and will gain the support of the other divisions.

COMMUNITY ACTION GROUP

B. Johnson: as a retired government employee, you are able to devote time to serving your community in many ways. You were selected by a small group of neighbors to represent your community in the Community Action Group. As a Community Action representative for the Bay Ridge Community who is very familiar with the Bay area, you have been asked to represent the Community Action Group in the Environmental Council. The Environmental Council is an organization consisting of several small groups concerned with the uncontrolled growth along the Chesapeake Bay. Representatives of the Environmental Council keep the community members informed of environmental problems and hazards in order to protect their interests both in business and recreation. The Environmental Council consists primarily of conservationists, but it has invited members of the Bay community to become involved. Through a coordinated effort, the Environmental Council has strongly influenced the formation of policies that will protect the environmental quality of the Chesapeake Bay. The communities surrounding the Bay have contributed both money and personnel to the Council's efforts.

Joining the Environmental Council was a wise move on the part of the Community Action representatives, not only because the Environmental Council has influence, but also because the Environmental Council has recently joined forces with another larger organization, Bay Interest Groups (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR) in areas of management policy. The Environmental Council is one of seven divisions of the BIG Conference. Each division consists of groups with similar interests. Your division of BIG is probably the most unified, because it joined as an already established group. Even though there are a number of groups that will differ with your position, you feel confident that your new division will be well prepared and will gain support of others. The major issues that concern your group are continued building and development, and the great influx of persons from outside the area for recreation purposes. The Community Action Group feels that housing development should be curtailed, and the continued development of recreation sites should be slowed.

BIG Conference Roles–DEVELOPERS

CHESAPEAKE HOME BUILDERS' ASSOCIATION

T. Gilbert: of Davidsonville, Maryland. You have built homes in the suburban areas around Washington and Baltimore for twenty-two years. When you first started in the construction industry, you had two employees and did a lot of the house framing and handwork yourself. Your company, Gilbert Homes, now employs as many as 600 people in the peak building season.

Ever since World War II, growth in government and related fields has caused a demand for new housing. You used to build only single-family homes, but as costs for labor, materials, and land have skyrocketed, new housing patterns have become necessary. Most people cannot afford the $100,000 price that quality new homes must sell for. Townhouses, condominiums, and other cluster-housing patterns must make up most of your business. You can build them to sell for a price that people can afford to pay. However, it is getting more difficult finding land with available sewer hook-up and drinking-water supplies. You believe concerns for the quality of life and the environment are important, but as long as the population continues to grow people will need places to live, and your industry will have to build more homes.

You are the spokesperson for the Chesapeake Home Builders' Association, formed with other builders, to help publicize your point of view. You realize that the Bay region needs to preserve its environmental quality, but not at the cost of progress.

To further your efforts, the Home Builders' Association has joined the large organization called Bay Interest Groups (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR). By joining this organization, you will save money on lobbyists, and you will increase your influence. The Chesapeake Home Builders' Association decided that you should represent them at the BIG Conference. You are split between preserving the environment that you love and wanting to continue development to increase profits. There must be a way to do both. You look forward to working with the developers division at the BIG Conference. This division is only one of the seven represented at the conference, but it consists of people with large financial interests as well as environmental concerns. You know many of them professionally. There are realtors, bankers, commercial construction workers, and economists in this division. To you, these are all the persons necessary for wise decision making.

UNITED REALTORS' ASSOCIATION

P. Martin: As public relations representative of the United Realtors' Association you represent almost every real estate company in the area. You serve your members by informing them of current government activities that affect your business including proposed zoning changes, sewer moratoria, and legislation. You hold meetings to discuss and prepare the association's positions on these matters.

Real estate requires a lot of foresight about housing patterns and future trends in the market. There are few places in the United States with such a sizable population of well-paid families as in the Baltimore-Washington area. Also, the population here is very mobile, with the average family moving every three or four years. These two factors—wealth and mobility—create an ideal real-estate market. Your industry makes six percent profits in commissions for every house that is sold. No salaries are paid, since one sale a month pays enough commission to keep most people in the business. Many salespeople sell more than one house a month.

More homes are advertised for sale with waterfront access every day. This waterfront access adds thousands of dollars to the value of the house. People want to sail and fish on the Chesapeake Bay and are willing to pay for it. You wonder how long development can continue and still preserve the quality of the Bay for people to enjoy. Part of your job is to see that further development does take place to maintain the interests of your company and other companies like it. You recently joined a large organization called Bay Interest Groups (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR) on management policy. By joining this organization, you feel that you can really increase your influence. Since joining BIG was your idea, you have been made the representative to the BIG Conference. You are looking forward to working with the developers division at the conference. You believe further development will be a common concern. This division is only one of seven in BIG, but it is made up of people with large financial interests as well as environmental concerns. The members of this group are your colleagues in the business world. You know many of them professionally. There are home builders, commercial construction interests, realtors, and economists in this division. To you, these are all the necessary people for wise decision making. You feel sure you can work with this group and see that your organization's concerns are dealt with and represented effectively.

ECONOMIC CONSULTANTS, INC.

F. Lauter of Mathews, Maryland. You partially own and manage a company called Economic Consultants, Incorporated. Your company is hired by builders and construction companies to study projects they are considering. You do detailed economic research and advise them which plans should make a profit and be successful, and which plans would be mistakes. Perhaps your greatest service is to interpret legal questions about sewage capacity, available drinking water, and taxation. Your firm includes seven lawyers and other paralegal staff members to research these questions. You produce reports on land-use patterns, economic forecasts, and other aspects of planning. You subcontract experts in architecture, engineering, and other fields when necessary, to get your customers the best and most up-to-date advice available.

The Chesapeake Bay region is an area with great projected growth in all economic aspects. You know that growth will occur, and it is your business to help it occur in a logical and planned fashion. You value the environmental quality and wish to see it preserved through careful, thoughtful planning. You intend to see that the quality of life is not downgraded by continued construction although you intend to guarantee the continued construction to all types of facilities.

You realize that environmentalists are lobbying in the state legislature. Since the creation of the Environmental Protection Agency, more state government officials are listening to these environmentalists. You are interested in getting your views represented. Although you are not opposed to the maintenance of environmental quality, you feel many of these scientists and concerned citizens go overboard in their concerns. You believe environmentalists want to curtail development and return to pristine conditions. In your professional opinion, this would be absurd. You intend to bring this point to the legislators.

In order to accomplish your goal, you have contacted a large organization called Bay Interest Groups (BIG). You know this organization can help increase your influence, because BIG serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). You are looking forward to working with the developers division who share your concerns, at the BIG Conference. This division is only one of seven in BIG, but it consists of people with large financial interests. The members of this division are your colleagues in the business world, and you know many of them professionally. There are home builders, commercial construction workers, realtors, and bankers in this division. These are all the necessary persons for wise decision making, in your opinion. You know that you can work with this division and see that your organization's concerns are dealt with and represented effectively.

BANKERS' ASSOCIATION

H. Setter from Upper Marlboro, Maryland. 32 years ago you entered the banking industry as a part-time bank teller while you worked your way through college majoring in accounting. Though you have worked for five different financial institutions, you have remained in the Washington-Baltimore region throughout your career. You are vice-president of one of the largest banks in Maryland and represent the Bankers' Association in which you promote the entire banking industry.

During your career, the banking industry has loaned a vast amount to finance the expansion and growth of the Baltimore-Washington metropolitan area. Your basic interests are to continue the development and growth that provide homes and jobs for the population, and profits for your stock holders. The Bankers' Association is a heavy contributor to campaigns of local, state, and national politicians who share your desire for continued economic growth. In recent years, environmentalists have raised their voices against unlimited development. You believe that as long as there is a growing number of people and business in the Chesapeake area, your banking industry will prosper along with the entire region. You would like to see an expansion of the construction market. This means more loans to construction companies as well as mortgages after construction is completed.

In order to make these expansions, policies that control development must be changed. There are currently too many government regulations on your business endeavors. Many of these controls supply government with money from license fees and permits. You realize this will not change, but if you can balance the controls of the environmentalists by lobbying and increasing public interest, this may prevent the creation of new fees.

Economic development is important. People need houses, shopping centers, hospitals, grocery stores, and banks.

You have contacted a large organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources. You are the Bankers' Association representative to the BIG Conference, and you want to increase your influence. You are looking forward to working with the developers division at the BIG Conference, a group with similar concerns to yours. This division is only one of seven represented at the conference, but it consists of people with large financial interests as well as environmental concerns. The members of this group are your colleagues in the business world, and you know many of them professionally. There are home builders, commercial construction workers, realtors, and economists in this division. These are all the necessary persons for wise decision making. You feel sure you can work with this group and see that your organization's concerns are dealt with and represented effectively.

COMMERCIAL CONSTRUCTION ASSOCIATION

R. Heffner of Bel Air, Maryland. Your company builds large commercial facilities such as shopping centers, factories, and hospitals. You joined similar companies to form the Commercial Construction Association in order to serve the needs of your industry and represent your point of view in government.

The Washington, Baltimore, and Chesapeake Bay region has experienced tremendous growth since World War II, and future predictions promise even more business for your industry. Members of your association build the roads, schools, sewage treatment plants, and other facilities that make growth possible in housing and employment. During your career, you have seen farms and small towns become suburbs and cities. Recently, industrial parks have concentrated employment and business in certain areas with organized planning.

Nevertheless, you believe that government regulations are excessive and make it difficult to make a profit. Required zoning, building codes, and numerous permits take too much time and money, and are too costly for your business. Even though you are concerned about the quality of the environment, you believe that human needs come first. The organization you belong to has banded together to decrease government restriction and to increase profits by further development. You have been in contact with a large organization called Bay Interest Groups (BIG), which serves in an advisory capactiy to the Maryland State Department of Natural Resources (DNR). You are the Commercial Construction Association's representative to the BIG Conference. You want to ensure further development and thus guarantee further construction, but you also love the Bay area. Continued development, if uncontrolled, will surely destroy the area, yet the controls imposed already are a serious hindrance to your business. There must be a way to do both. Development must go on, and human needs must be met. You are looking forward to working with the developers division of BIG. This division is only one of seven in BIG, but it consists of people with large financial interests as well as environmental concerns. The members of this group are your colleagues in the business world, and you know many of them professionally. There are bankers, home builders, realtors, and economists in this division. To you, these are the necessary people for wise decision making. You feel sure you can work with this group and see that your organization's personal concerns are dealt with effectively.

BIG Conference Roles–*RECREATIONISTS*

CHESAPEAKE BAY YACHT OWNERS' ASSOCIATION

E. Whitehead: as spouse of the president of the Mercantile Bank and Trust Company and owner of a 40-foot yacht that is anchored at the Chesapeake Bay Marina, you and your spouse often use your yacht to entertain clients on the family boat for excursions along the Bay or for small parties in the evenings. Your family enjoys swimming and fishing off the boat as well.

You are both members of the Chesapeake Bay Yacht Owners' Association, but you will be spokesperson for the Association at the meetings of BIG. You want to see strict regulations put on solid and liquid waste disposal into Bay waters, and limited use of the Bay by huge oil tankers that could cause oil spills. You also oppose the presence of large cargo vessels and flatbed boats that carry refuse; these boats disturb the aesthetic beauty of the Bay.

You would like to see development of the land that would bring more money into the area. You support small business owners and commercial construction companies that will boost the economy. At the same time, you wish to maintain the beauty of the Bay and prevent pollutants. Many members of your association are quite successful in business and are frequently at odds within the group when confronted with a controversial issue. You have the difficult job of accurately representing the interests of this diverse group. You will attend a conference held by the Bay Interest Group (BIG). BIG serves as an advisory group to the Maryland State Department of Natural Resources (DNR). BIG is divided into seven divisions, all having similar concerns. The division your group belongs to is recreation. This is probably the most diverse division, and you frequently have heated conflicts with other groups, especially when discussing development and commercial expansion. Along with the Chesapeake Bay Yacht Owners' Association, the Recreation group comprises the Chesapeake Bay Sport Fisherman's League, the Chesapeake Bay Visitors' Association, the Beach Owners' Association, and the Game Hunters' Association. You must be able to represent your group's interests, and still compromise and cooperate with other groups at the BIG Conference.

CHESAPEAKE BAY SPORT FISHERMAN'S LEAGUE

F. Johnson: as a 48-year-old self-employed carpenter from South Baltimore who earns about $30,000 a year, you and your friends usually rent a boat and go fishing on the Bay each weekend.

You are a member of the Chesapeake Bay Sport Fisherman's League, and have been fishing in the Bay since you wre 10 years old. When you were young, you used to catch some rockfish, but now you catch mostly bluefish, white perch, shad, and flounder. Howver, you've noticed that the quantity and size of the fish have decreased.

Your group advocates restrictions on commercial shipping to ease Bay traffic and prevent possible oil spills. You support the environmentalists and wetlanders in opposing the industrial pollution of the Bay environment and harmfulness to the natural wildlife. In particular, you would like to see quotas for commercial fishermen, so that there will be good catches for the sport fishermen as well. Special piers with bait and tackle suppliers would add to the economy and growth of the area.

Now that your family is grown, you have taken a more active role in the Fisherman's League. You have held various leadership roles in the league and have helped the league become a close, action-oriented group. Many years ago the league joined a much larger group, Bay Interest Group (BIG), which is an advisor to the Maryland State Department of Natural Resources (DNR). You, as the current representative of the league, go to all BIG functions, and report on the progress and news. The BIG Conference is divided into seven divisions, each of which has similar concerns. The division your group belongs to is recreation, probably the most diverse subgroup within BIG. There are frequent and highly emotional arguments from members of your division. Along with the Chesapeake Bay Sport Fisherman's League, the recreation group consists of the Beach Owners' Association, the Game Hunters' Association, the Chesapeake Bay Visitors' Association, and the Chesapeake Bay Yacht Owners' Association. You have the difficult job of representing your group's interest while also cooperating and compromising with many other groups. You are prepared to stand firm on the issues of improved quotas for commercial fishermen and a decrease in the level of industrial pollution.

GAME HUNTERS' ASSOCIATION

T. Swanson: of Calvert County, Maryland—as a retired airline pilot, you enjoy hunting wild geese and ducks in the Bay area during hunting season. In fact, five years ago you won the coveted National Duck Hunters' Award for marksmanship.

You are past president of the Chesapeake Bay Game Hunters' Association and are very vocal about restricting land development and commercial construction. You support the environmentalists and wetlanders in preserving the natural wilderness and wildlife of the area. You vehemently oppose the industrial businesses (plants that pollute the environment and destroy the wildlife habitat). You feel that strict controls should be placed on the shipping of oil along the Bay because of the possibility of oil spills that could destroy the birds and fish. You are also concerned about inconsiderate tourists who leave beer cans and other trash that spoils the beauty of the shore and endangers the wildlife.

Because of your concerns, you joined the Game Hunters' Association of Maryland many years ago. This group spans the entire state and represents the concerns of the game hunter. Recently, the group has become interested in the area of Maryland around the Chesapeake Bay. This area seems far more endangered than some of the areas in the western portion of the state. Members of the Game Hunters' Association have become interested in increasing their level of influence on policy development for the Chesapeake Bay. They joined the Bay Interest Group (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). BIG is divided into seven divisions, each with similar concerns. The division your group belongs to is recreation, probably the most diverse and argumentative division of the BIG Conference. Along with the Game Hunters' Association, the Recreation division consists of the Beach Owners' Association, the Chesapeake Bay Visitors' Association, the Chesapeake Bay Sport Fisherman's League, and the Chesapeake Bay Yacht Owners' Association. You have the difficult job of representing your group's interests, while also cooperating and compromising with many other groups. You want to stand firm on the issues of limited development of industry on the shore, and you oppose any further development of the wetland areas, since they are excellent hunting grounds.

BEACH OWNERS' ASSOCIATION

W. Jordan: You own a shoreline home located in Talbot County that has been in the family for four generations. You own a private dock for your family's motorboat and catamaran. When you were younger, you used to fish off the dock and catch spot and striped bass. Within the past five years, you have noticed a decrease in the quantity and size of the fish, as well as oil spots on the sand.

Recently, land developers have been inquiring into your property and nearby areas. They want to build vacation and retirement homes, and open waterfront access to adjacent inland areas. You are opposed to these land developers who, you believe, will spoil the natural beauty and serenity of your home and congest the area with commercial business personnel who will not respect or value the aesthetics of the Bay.

Also, you have noticed some erosion on the shoreline and sedimentation that clots the stream on your property. This is probably due to the industrial waste material, land development, and poor farming practices that dump sediments into the Bay.

As a member of the Beach Owners' Association, you want to eliminate this pollution and the reckless land development and construction that is occurring. You support the environmentalists and wetlanders in the preservation of the natural environment and wildlife habitat. However, you would like to see regular spraying of the mosquitoes and limitations put on the game hunters who cause several accidental deaths each hunting season.

Members of the Beach Owners' Association want to increase their level of influence on policy development of the Chesapeake Bay. In order to do this, they have joined an organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). The BIG Conference is divided into seven divisions, each with similar concerns. The division your group belongs to is recreation, probably the most diverse division. Due to this high level of diversity, there are frequent and highly-emotional arguments from members of your group. Along with the Bay Owners' Association, the recreation group consists of the Game Hunters' Association, the Chesapeake Bay Visitors' Association, the Chesapeake Bay Sport Fisherman's League, and the Chesapeake Bay Yacht Owners' Association. You have the difficult job of representing your group's interests while also cooperating and compromising with many other groups. You stand firm on issues like eliminating pollution and slowing land development.

CHESAPEAKE BAY VISITORS' ASSOCIATION

J. Watson from Gaithersburg, Maryland. During the summer you and your family drive to the Bay to enjoy the beach and go camping. However, you have become discouraged at the overcrowded beaches and the lack of public access to much of the privately-owned beachfront property.

You have volunteered to chair the Chesapeake Bay Visitors' Association. You advocate state acquisition of shoreline property to create state recreational parks that provide public camping and swimming facilities. Bay visitors bring much money into the Chesapeake Bay area and deserve adequate recreational facilities.

You advocate regular spraying of the wetlands for mosquito control and nets to prevent stinging sea nettles in the swim areas. You oppose the industrial pollution of the Bay, and the presence of oil tankers on Bay waters. You support some small business operations to aid visitors, such as restaurants, gift shops, and hotel facilities.

You have been the uniting force for the Bay Visitors' Association. You are proud of this group for organizing and defining the issues they wish to push for. They want to increase their influence on policy development for the Chesapeake Bay. In order to do this, they have joined an organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). The BIG Conference is divided into seven divisions, each with similar concerns. The division your group belongs to is recreation, probably the most diverse division within BIG. Due to this diversity, there are frequent highly-emotional arguments from members of your group. Along with the Chesapeake Bay Visitors' Association, the recreation division consists of the Beach Owners' Association, the Game Hunters' Association, the Chesapeake Bay Sport Fisherman's League, and the Chesapeake Bay Yacht Owners' Association. You have the difficult job of representing your group's interests, while also cooperating and compromising with many other groups. You stand firm on such issues as state acquisition of more land for public access and further development of tourist industries and services.

BIG Conference Roles—*PRIVATE INTERESTS*

HOME OWNERS' ASSOCIATION

H. Honner of the Western Shore of the Bay north of Annapolis. You are employed by the U.S. Office of Education in Washington, D.C., and commute 40 miles each day. Your spouse owns a craft-and-pottery shop in Annapolis. You are willing to commute because you love living on the Bay shore and sailing the family sailboat into the Bay from your private pier.

The Home Owners' Association is a large organization made up of people like you who own homes on the Bay shore. There are Eastern Shore and Western Shore chapters. You are currently chairperson for the entire organization. The association is large, because 97 percent of the shore land of the Chesapeake is privately owned. A large part of this land is commercial, but much is private residences.

The objective of the Home Owners' Association is to maintain the current living standard on the shore and to work toward improved living conditions. Your group supports the limitation of many commercial activities on the Bay, especially industrial development. These activities take away from the aesthetic beauty of the Bay. Developers are also often at odds with your group when they decrease the aesthetic beauty by building and causing overcrowding. To some extent, your group shares the concerns of the recreation groups because you and many members of the Home Owners' Association enjoy these activities. Your group's goals are to protect the environment, and you have donated money to environmental organizations.

Your association is part of a larger organization called Bay Interest Groups (BIG) that serves in an advisory capacity to the Maryland State Department of Natural Resources. The BIG Conference is divided into seven divisions, each with similar concerns. The division your group belongs to is private interests. This is clearly one of the more diverse divisions. Along with the Home Owners' Association, this division consists of the Double "F" Association (farmers and foresters), the Small Business Association, Sand and Gravel, and the United Marina Owners' Association. You and the representatives from these groups have been able to work cooperatively at the Conference despite diverse viewpoints. You may argue, but you usually can reach agreement.

DOUBLE "F" ASSOCIATION (Farmers & Foresters)

P. Ameri, a farmer from southern Prince George's County. The government regulations limit you to seven acres of tobacco; therefore you also truck farm. During the summer months, you grow various kinds of vegetables, which you drive to the Washington, D.C. area weekly. You have a large farm, but you are finding it more and more difficult to make money from farming each year. Profits are hindered by government regulations and the high cost of equipment, labor, and supplies. For this reason, you and your fellow farmers have met and formed an organization to protect your concerns.

Your organization has limited funds and therefore you have recruited foresters with similar concerns to join your organization. Some of these foresters are Maryland state employees; others are owners of large tracts of forest land or farmers with large tracts of land in pulp wood. Your organization is named the Double "F" Association for both farmers and foresters.

Your group opposes sedimentation that would destroy your farmland, limitations on the use of fertilizer, which is essential to your survival, and the rapid urban growth that competes for the use of the land.

You recently have been voted the representative of your group to serve on another, much larger organization, Bay Interest Groups (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR). The BIG Conference is divided into seven divisions, each containing several groups with similar concerns. The division your group belongs to is private interests. This is a diverse division, but you have been able to work cooperatively with the representatives from other members of the division despite diverse viewpoints. Along with the Double "F" Association, the private interests division consists of the Home Owners' Association, the Small Business Association, Sand and Gravel, and the United Marina Owners' Association.

SMALL BUSINESS ASSOCIATION

C. Zimmerman, the owner of a seafood restaurant in Cambridge, Maryland. Your restaurant specializes in fresh fish caught on the Bay daily. Your life centers on the problems of the small business owner. Fast-food chains are causing many small restaurants to close. In the retail and grocery markets the chain stores (big business) are gradually choking out the small businesses. Because of your anger with the current situation you have become active in the Small Business Association.

The main concern of your association is how to ensure a clientele. If the Bay is kept beautiful, businesses around it can be productive. You therefore support recreation activities that bring many visitors to the Bay area and help maintain small businesses. You support the environmentalists in keeping the Bay beautiful for people to come and enjoy and spend money while there. You support the fishermen and farmers who supply the products not only for your business but for many others as well. You are against groups who want to return the Bay to its original pristine state, because this means no people, and no people means no business. You are against industry when they destroy areas of the Bay, but industrial employees are a very important part of your clientele.

The Small Business Association has voted you their representative to serve in another larger organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). This will take up a great deal of your time, but you feel that it is worth it to obtain attention from the state in favor of small business interest.

You are to attend a BIG Conference soon. The conference will be divided into seven divisions, each containing several groups with some similar concerns. The division your group belongs to is private interests. This is clearly one of the more diverse divisions, but you have been able to work cooperatively with the representatives from other members in your group despite diverse viewpoints. Along with the Small Business Association, this division of the BIG Conference consists of the Home Owners' Association, the Double "F" Association (farmers and foresters), Sand and Gravel, and the United Marina Owners' Association.

SAND AND GRAVEL COMPANY

H. Shore: You are the owner of a dredging company that removes and sells sand and gravel. You previously worked for the International Shipping Co., where you saw the trend to larger ships. Channels, harbors, and other areas needed to be dredged to allow for these new, huge ships. The rate of sedimentation on the Bay is high due to construction and heavy agriculture around the Bay. The cost of removing sand and gravel from the channels, subestuaries, and harbor facilities is increasing. The need for construction in shore areas, though it contributes to sedimentation, also requires large quantities of sand and gravel—the goods you market.

Two years ago you began your current business, The Shore Sand and Gravel Company, and have found it a profitable business. Many others have gotten into the dredging business.

Although you compete with other businesses, you each cooperate in order to ensure that your interests and concerns are protected. A group of dredging companies formed the Sand and Gravel Company group. The Sand and Gravel Company group meets regularly to discuss what legislation and new developments should be supported or opposed.

Elected officials in the organization are responsible for the administration of the group. You are the elected representative of the Sand and Gravel Company to the Bay Interest Groups (BIG), which serves as an advisor to the Maryland State Department of Natural Resources (DNR). BIG is having a conference composed of seven divisions, each with similar concerns, to advise about Bay policy. Your private interest division is one of the more diverse divisions. Along with the Sand and Gravel, the private interest division is made up of the Double "F" Association (Farmers and Foresters), the Small Business Association, the Home Owners' Association, and the United Marina Owners' Association. You are able to work cooperatively with the representatives from these other groups despite diverse viewpoints and usually can reach agreement.

Your group has many concerns including dredging, which can have a devastating effect on the Bay by changing the topography of the Bay floor. This can affect the flow of water, which in turn affects the sedimentation rate. You must be careful not to destroy either your industry or the Bay itself. The rate of sedimentation is seasonal but is also dependent on shore developments. Agriculture and construction disturbances of the soil produce a high amount of sedimentation. The major market for your products is the construction companies and some government and industrial contracts. Your group favors construction increases and rapid urban growth and supports campaigns begun by BIG's division of developers and industry. Your group does not, however, wish to damage the Bay; thus, you support some environmental issues. Since your business is scientifically-oriented, you and the members of your group try to keep well-read and knowledgeable on new developments in science.

UNITED MARINA OWNERS' ASSOCIATION

E. Holloway: You and your spouse are owners of a large marina and seafood restaurant in Deal, Maryland. Owning and running the marina was not big business, but for the past ten years there has been a steady increase in demand for marina space. Boat traffic has increased tremendously in Deal; there is seldom a space available in your marina. Many marina owners have built additional dock sites in order to accommodate more boats and make higher profits. The construction of many new small businesses and homes has also contributed to the need for larger marina space. You could probably add docking areas to your marina if you reorganized your space, but you would rather spread out than crowd.

There are disadvantages as well. There is a constant oil slick on the water, and the level of pollution in the marina area has gone up drastically. The expense of dredging is high, but more boat traffic increases the need for it.

Like yourself, many marina owners are looking for shoreland on which to expand. The land with good conditions for marinas is getting more difficult to find. These are only a few of the issues that concern you and members of the United Marina Owners' Association.

You have benefited greatly by joining this group. The members meet regularly and discuss common problems. This group is interested in legislation, taxation, and the activities of other groups who use and misuse the Bay. The United Marina Owners Association has joined a larger and more powerful organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department Natural Resources (DNR). The BIG Conference is divided into seven divisions, each containing groups with similar concerns. The division your group belongs to is private interests, which is clearly one of the more diverse divisions. Along with the United Marina Owners' Association, the private interests division consists of the Home Owners' Association, the Small Business Association, Sand and Gravel, and the Double "F" Association (farmers and foresters). You have been able to work cooperatively with the representatives from these groups despite divergent viewpoints and usually can reach agreement on issues for the conference.

BIG Conference Roles—*INDUSTRIALISTS*

EAST COAST STEEL

M. Washburn. You are the director of public relations of East Coast Steel and a natural for any type of job involving contact with the public. You were an outstanding gymnast in both high school and college. Except for an unfortunate and nagging knee injury, you could possibly have made the U.S. Olympic Team. You reflect all of the discipline, ability to communicate, charm, and polish of an accomplished gymnast.

Your job at the steel company is a lot more complicated than you thought it would be. Over 20,000 employees of the company take home a payroll of about $400 million a year, and with various benefit costs, another $100 million is added. For the goods and services it uses, the company contributes another $120 million into the local economy, and in addition it pays millions of dollars in taxes.

Despite the money your steel company has brought into the area, there have been problems. For instance, in the past, the docking facilities could handle the import and export of the raw materials and finished goods. With the new supertankers and large iron-ore carriers, the steel company had enough foresight to construct a $60 million pier to handle the newer ships. However, the new ships draft deeper than the harbor and Bay channel can handle. Despite the new pier, iron ore is still largely carried by the smaller ships. The company also runs a ship repair yard in the harbor, but the repairs are limited to the general cargo ships since the superships cannot reach the drydocks.

The steel company is being forced to add on environmental controls to its production. These new controls will cost $130 million in addition to the $20 million to maintain the existing controls. All of these—inflation, environmental controls, and reliance on the expensive smaller ships—add on costs and problems for the company. Also, foreign steel is being imported at prices the company can hardly compete with.

You have been able to convince most citizens and government officials, that, if Baltimore is to remain competitive with other port cities, the channel will have to be deepened. You want to impress on the citizens that it is in their best interests to help the company remain a viable enterprise in order to keep this big business in the Baltimore community.

Because you have the right personality and connections, you represent the steel company at a larger organization called Bay Interest Groups (BIG). BIG serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR) in the development of management policy for the Bay. The BIG Conference is divided into seven divisions, of which each division includes groups or companies with similar interests. You will be working with the industrial interests division along with the Metro Steamship Agency, United Petroleum, the Chesapeake Bay Power Company, and the Harbor and Port Consultants. You feel that if you support further development of industrial sites and dredging, the industrial division will be able to locate allies and accomplish their goals. You realize that there will be many divisions at BIG Conference who will oppose these suggested changes. You are currently trying to determine how you can negotiate with the environmentalists and other groups who oppose further development of the Bay Region.

METRO STEAMSHIP AGENCY

W. Moskowitz: You are the owner of the Metro Steamship Agency in the port of Baltimore. You began your career in shipping by joining the merchant marines during World War II. After the war, you remained in shipping and eventually became a freight broker. (A freight broker is a person whom a company would seek out to take care of all the necessary details to guarantee that whatever cargo had to be shipped arrived at its destination as quickly as possible).

You started your own steamship agency after ten years. The company does not own any ships, and it does not want to. You are shipping agents—the freight brokers now come to you and ask if you can guarantee that a ship can take a load of cargo from Baltimore to another port. Your job is to check all of your contacts, some dating from the war, to see if you can persuade a ship's owner to stop in Baltimore to pick up a load for Antwerp, for example.

The success of the business depends on your ability to have the ships ready to pick up the cargo without any delays. You know that one day at anchor for a ship costs about $15,000. You love the competition of owning and managing a steamship agency. You have assembled a very competent staff to take care of the fees, licenses, and other information required for the shipping of cargo from port to port. All you have to do is make decisions, such as if a ship will be unloaded tonight or tomorrow. Your staff carries out your decisions.

There are two basic types of shipping—general cargo and bulk. Metro Steamship Agency deals with the cargo aspect. Cargo ships draft 35-36 feet, and the harbor is deep enough to handle such ships. You do have a problem with the Chesapeake and Delaware Canal, however. Because the C. & D. Canal is only 27-28 feet, ships have to sail up from the south, adding about 24 hours to the journey. You know that several shipowners have said it is not worth spending the extra time and money; they'll just look for another port.

A good steamship agency gets the ships in and out of the port in a hurry. You are one of the best, but you could have brought a lot more business to the port if they would just dredge the C. & D. Canal. The dredging, the crowding in the Baltimore Harbor, and the packaging of the cargo itself are only a few of the problems you face. You are becoming concerned about government policy in these areas. For this reason, you have joinged BIG, or Bay Interest Groups, a large organization that serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). You feel that this is a good way to get your company's interests represented. You are in favor of dredging the Bay channels, the C. & D. Canal, and Baltimore Harbor for the very large supertankers. You also would like to see expanded development of the harbor itself. In looking over the seven divisons within the BIG Conference, you can see that your industrial interests division will be very unified in their approach to these issues. You will be working with East Coast Steel, United Petroleum, the Chesapeake Bay Power Co., and Harbor and Port Consultants. Some groups will readily ally with you, but groups will oppose these recommendations. You realize no decision will come easily, and you need to research the issues in order to bargain effectively with other groups.

UNITED PETROLEUM

E. Banks, an executive vice-president in charge of acquisitions for United Petroleum. You began your career in United Petroleum as a gas station attendant for one of the company-owned stations. Through determination and sound business judgments, the company sent you to a business management school. You graduated to become a middle-level executive and, within a relatively short time, you rose to your present position. You quickly learned how important petroleum products are to Americans.

The Chesapeake Bay Region uses so many petroleum products that refineries must be located in the area to provide the products at the lowest possible cost. Demand for gas and oil is rising every year. The easiest way, short of an Alaskan-type pipeline, is for the supertankers to bring the oil to the refinery. Currently, they can't sail up the Bay because of the shallow channel. Also, some people say that if there is an oil spill from one of these ships, the Bay would be damaged beyond repair. Your company takes every possible precaution. Although the news media seem to print stories only of oil spill accidents, there are billions of barrels of oil that safely make their destination.

Simply put, the region is using more oil and refineries need to be built to handle the need. The large tankers can bring in the crude oil at the lowest possible cost. In order to protect this business, United Petroleum has joined a large organization, called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). Although United Petroleum still has a large number of lobbyists in Annapolis at the State House, they felt the need to join BIG so that their position can be considered in policy development.

You will be representing your company at the BIG Conference soon. This conference will be held to determine BIG's stand on many issues involving the Chesapeake Bay. You will be working with one of the seven divisions at the BIG Conference that includes many other industries such as Chesapeake Bay Power Co., Harbor and Port Consultants, Metro Steamship Agency, and East Coast Steel. You feel these industries support your need for dredging. You hope that the other groups in your division will support your company's need to locate more refining plants in the Bay region. You also need the support of as many other divisions as possible. You are researching Bay issues to become familiar with the concerns of as many groups as you can. You feel that this could help your company at the conference.

CHESAPEAKE BAY POWER COMPANY

L. Greenburg, director of the research and development division of the Chesapeake Bay Power Company. You have always been fascinated by electricity—from an early age of watching horror movies on television when you wondered about the source of power—where it comes from and how it can be channeled and directed through wires.

You carried your fascination through school and obtained a degree in electrical engineering. You realized that the country's use of energy would keep increasing. Until the last several years though, you thought that it would be a matter of simply building more generators to satisfy the increased demands for power.

You were instrumental in the design of the first atomic power plant on the East Coast, and you are proud of that accomplishment. However, some environmental groups began telling the public that these plants were dangerous. You remarked to a friend: "I think that it's a bit unfair, all of these complaints. It's not like the power companies are creating a false need. If the public wants to use its blow dryers, electric knives, air conditioners, microwave ovens, and televisions, we have to generate the electricity to allow them to do it. The public indirectly tells us how much power it wants, and it is up to us to give it to them—by building new generating plants. People don't want the dams for hydroelectric power or the dirty air from the fossil burning plants.

Solar energy doesn't seem feasible at this moment. It's either nuclear energy or turn off the appliances. According to today's projections, by the year 2000, we're going to need ten more large nuclear plants in the Bay Region just to keep up with the demand."

"I don't think nuclear power plants are that dangerous. We go through detailed analysis during all planning stages and construction stages. We monitor the plant's operation very carefully. Power companies have the right to argue back. We need to present the other side of the problem."

So far this other side has been presented by the public relations department. However, recently the Chesapeake Bay Power Company joined a large organization called Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). By joining this group, the power company can have some input into actual policy development in the state.

Immediately after joining BIG you received word that a conference has been scheduled to plan management policy for the Chesapeake Bay. You will represent the power company along with the Harbor and Port Consultants, United Petroleum, Metro Steamship Agency, and East Coast Steel in the industrialist division of the BIG Conference. There are seven divisions of BIG; each one consists of groups or companies with similar interests.

You plan to support other industrialists' demand for dredging to accommodate new and increasing shipping needs. They will in turn support your need for increasing power supplies by developing new sources of energy and building new plants. This plan should come relatively easily since expanded industries require increased levels of power.

HARBOR AND PORT CONSULTANTS

E. Brown, director of Harbor and Port Consultants, Inc. You are proud of your current position because you have worked your way up from a labor position to managerial status. You know that those years of night school and experience as an engineer really paid off.

You do most of your consulting at the Baltimore Harbor. The harbor supplies the area with jobs, raw materials, and imported consumer goods. This happy picture has its problems. The harbor is small, but how and where could it be expanded? The channels in the Bay and the harbor itself are too shallow for the large supertankers. These are not only problems for the port, but they are also great concerns for industries in the Bay area.

There are many other questions that must be answered. For example, should the entire port change over to container shipping? This makes loading and unloading of cargo easier and quicker, but where is there room to store these containers?

Although Harbor and Port Consultants, Inc., has a lobbying staff at the state and federal levels, you have recently suggested they join another organization, Bay Interest Groups (BIG), which serves in an advisory capacity to the Maryland State Department of Natural Resources (DNR). You recently learned that a group of industries have banded together to become the industrial interest division of BIG. In this division you will work with the Chesapeake Bay Power Company, the Metro Steamship Agency, United Petroleum, and East Coast Steel. The BIG Conference is divided into seven divisions that represent the interests of many diverse groups. A conference is planned to investigate and write policy-management statements for the Chesapeake Bay Region. You feel this is an excellent way to get the harbor's needs acted upon. You know that the other members of your division will present a unified case for further dredging of the Bay and harbor, and possibly the Chesapeake and Delaware Canal. This will allow the Bay area to use larger ships. You are also hoping for a policy of expanded industrial development in order to mandate expansion of harbor facilities and more business for the entire harbor area. You realize that these will be difficult objectives because environmentalists will oppose them. You feel that we can develop further around the Bay and near Baltimore without destroying the aesthetic beauty of the Bay region. You feel you have the united support of your division, and together you will have considerable influence.

CHESAPEAKE BAY ISSUES

1. Recreational boating
2. Commercial shipping
3. Dredging and disposal of dredged materials
4. Harvesting aquatic resources
5. Tidal and nontidal wetlands
6. Shore erosion
7. Use of flood plains
8. Use of agricultural lands
9. Beach access
10. Onshore oil and natural gas facilities
11. Electric-generating facilities
12. Ports
13. Industrial parks
14. Residential development
15. Sewage-treatment facilities
16. Land transportation facilities
17. Forested lands
18. Mineral extraction
19. Channelization
20. Recreational, open-space, and natural areas

CHESAPEAKE BAY ISSUES

Defined

1. Recreational boating and marina development

Recreational boating is second only to the Port of Baltimore in Maryland's marine-minded economy. Since most marinas are filled to capacity, more public launch facilities are needed. Some environmental problems include shoreline erosion, turbidity, oil-spill pollution, safety, and congestion.

2. Commercial shipping

The Port of Baltimore generates about 12% of the Gross State Product and over 250,000 jobs. Environmental problems include oil-spill pollution, channel dredging, shore erosion, and safety. Other toxic materials also threaten the Bay when transported.

3. Dredging and disposal of dredged materials

Dredging is necessary to keep ship channels open. The spoil (material removed from the channel) must be disposed of safely so as not to endanger shellfish beds or other resources. Containment sites have not been found for the spoil. Many sites are badly polluted from Baltimore Harbor and cannot meet the needs of the next 20 years.

4. Harvesting living aquatic resources

Fish and shellfish from the Chesapeake Bay are a major part of Maryland's recreational and commercial life. Overfishing, agricultural runoff, sewage, stormwater discharge, and industrial discharge all threaten these living resources. Moratoriums on the taking of striped bass and shad are already in effect.

5. Tidal and nontidal wetlands

Wetlands play a key role in Maryland's estuarine environment. They provide basic nutrients in the food chain and habitat for many fish and wildlife species, as well as help protect water quality, give flood protection, and help control shore erosion. Tidal wetlands are protected to a degree, but there is still considerable pressure to alter (fill or develop) wetlands.

Freshwater (nontidal) wetlands provide valuable wildlife habitat and food, particularly to waterfowl and fur-bearers. These communities serve as buffers for storm water, aquifer recharge areas, and filters for sediment and pollutants. Agricultural drainage, urban development, and many other activities threaten nontidal wetlands.

6. Shore erosion

Erosion over four feet per year threatens about 140 miles of Maryland's Chesapeake shoreline. Altering currents with structures along the shore can increase erosion, damage oyster beds, and cause sediment to fill creeks. Storms can cause much greater erosion damage than normal weather conditions to these developed shorelines.

7. Use of flood plains

Building in flood plains risks a great loss of life and property in times of storms, as well as causing changes to biological resources found in those areas. Development of flood plains can increase the extent and frequency of flooding problems. Such development is increasingly restricted.

8. Use of agricultural lands

Much of the Bay area is agricultural with over 10,000 farms. Increasing home-development pressures encourage building on prime agricultural lands. Agricultural runoff is an important source of nonpoint pollution in portions of the Bay and its tributaries.

9. Beach access

Most Maryland beaches are along the Atlantic coastline. Transportation routes must be available to give access to these beaches without damaging natural resources such as wetlands and without damaging existing developments.

10. Onshore oil and natural gas facilities

These facilities include fabrication yards, service bases, pipeline facilities, terminals, refineries, gas treatment plants, and marine terminals. If recoverable finds are made in the Outer Continental Shelf, environmentally safe locations and operational techniques must be found in order to maintain water-quality standards.

11. Electric-generating facilities

"Acid rain," nuclear power, localized effects of power plant operation, conservation programs, and the cost of electricity are major considerations in meeting Maryland's growing energy demands.

12. Ports

Ports important to Maryland include Baltimore, Salisbury, Cambridge, and Piney Point. Small-port development such as at Crisfield is a possibility. Problems associated with port development are dredging, spoil disposal, and pollution, as well as impacts of heavy rail and truck traffic.

13. Industrial parks

Industrial parks average over 300 acres and provide facilities for several types of industries. These parks have a great economic importance to an area by providing jobs and taxes. Industrial parks also can have great environmental impact with certain kinds of activities and the surrounding areas.

14. Residential development

Maryland shorelines are increasingly popular for large and small scale residential development. Negative impacts occur when the facilities' demands (such as sewage treatment plants, police, schools, fire) exceed the areas' capacity to pay for them. Sedimentation, nonpoint pollution, and loss of valuable habitat can occur with growth of any size.

15. Sewage-treatment facilities

The impact of sewage facilities on shellfish can be severe when sewage harms the water quality (oxygen, nutrients, and residual chlorine, for example). Sewage-treatment plants also increase high-density development because more treatment capacity is available.

16. Land transportation facilities

In recent years beltways have helped move populations from cities to suburbs. Highways spur development and determine its nature. Problems associated with this phenomenon include the cost of construction and labor for clearing and stripping the land; the use of herbicides and road salts; and continued maintenance due to erosion and sedimentation.

17. Forested lands

Timber is an important crop. Forests also serve as natural buffers, watershed protection, wildlife habitat, and recreation areas. Most Maryland forests are privately owned. Environmental problems such as erosion and sedimentation occur when poor practices (such as poorly drained roads or no reforestation) are used in timber harvesting.

19. Mineral extraction

According to present estimates, a 10-to-15-year supply of sand and gravel for general construction exists within Maryland. Currently there are 150 sand and gravel companies. Waste fine material (from washing the extracted matter) is a major sedimentation problem for the environment.

20. Recreation, open space, and natural areas

As the population of Maryland increases, more recreational facilities are needed. One type of facility needed is natural areas. One such area the state has acquired is the 2,700-acre Wye Island. There are plans for more recreation and open-space facilities.

BIG

Bay Interest Groups

11495 Eve Street
Annapolis, Maryland
21404

MEMORANDUM

TO: Bay Interest Groups (BIG) Conference Delegates

FROM: BIG Conference Chairman A. Sydenham
A. Sydenham

RE: Public Policy Statements for the Selected Issues

The Department of Natural Resources has sent us a memorandum regarding the recommendations which we will submit from this conference. BIG is instructed to take a united stand on each of the four issues. This can best be accomplished by having each interest group write a policy statement for each issue. This policy statement should represent the concerns of your interest group. The Chesapeake Bay Data Bank is available to each interest group to help determine and justify its policy statements. Once each group has written the four policy statements, each group should prepare a brief rationale of its views for presentation to the other groups. Each group should also write each public policy using the recommended format to be turned into the Chairperson for reproduction and distribution at the next session.

During the next session each interest group will have five minutes to present its policies. Questions and debate will follow the last presentation.

BIG **Bay Interest Groups**
11495 Eve Street
Annapolis, Maryland
21404

MEMORANDUM

TO: Bay Interest Groups (BIG) Conference Delegates

FROM: A. Sydenham
Conference Chairperson
A. Sydenham

RE: Policy Voting Procedures

After each group has presented its policies, negotiation, bargaining, and voting will take place in rounds. Each interest group will have opportunity to negotiate and bargain for its own policies between each round.

The rules for voting are as follows:

1. First Voting Session

Twenty-eight cards, numbered 1-28, are placed on a table. The numbers on the cards correspond to the list of policy statements distributed to all members of the BIG conference.

Each interest group receives 12 voting chips. Each group must determine which policy for each issue it will support. Groups should negotiate, and form alliances with other groups wherever interests are similar. When voting takes place, one member of each group will bring a ballot to the chairperson and place the chips on the appropriate card or cards.

The time permitted for negotiating and bargaining will be 10 minutes. The time allowed for voting will be limited to 3 minutes, so consider the choices carefully. The public policy receiving the largest vote will be raised to the agenda for further consideration by placing the numbered card between the "For" and "Against" cards.

2. Subsequent Voting Sessions

The second and subsequent rounds of voting require each interest group to use its 12 voting chips in two simultaneous votes:

1) Raising to the agenda: Some or all of the chips may be used to vote another policy statement onto the agenda. Follow the procedure followed in the first round. The policy card obtaining the largest vote will be moved between the "For" and "Against" cards for the next round of voting.

2) Accepting or rejecting a policy on the agenda: A policy statement was raised to the agenda in the first voting round. Since this policy was probably not considered or supported by all the interest groups, it is voted on again in order to represent a unified BIG policy position on the issue. Each interest group will place some or all its chips on the "For" or "Against" card. The policy is accepted if it receives a simple majority of the voting chips placed on the "For" card. If it is not approved, the policy card is returned to the game table. It can be voted up to the agenda during a future voting round.

Since the vote for raising a policy statement to the agenda is occurring simultaneously with a vote for or against a policy on the agenda, each interest group should use its chips with discretion. Each group will have to determine if it wants to vote to raise another policy statement to the agenda, vote for approval or rejection of the policy statement currently on the agenda, or split its chips between each vote. Interest groups can use their chips in any manner they think best; however, all 12 chips must be used during each voting round.

There will be as many rounds of voting as needed to approve at least one policy for each of the four Bay issues.

DEPARTMENT OF NATURAL RESOURCES
ENERGY AND COASTAL ZONE ADMINISTRATION
TAWES STATE OFFICE BUILDING
ANNAPOLIS, MARYLAND 21401

MEMORANDUM

TO: Bay Interest Groups (BIG) Conference Delegates

FROM: Maryland Department of Natural Resources

RE: Assessing the Environmental Impact of Public Policy

As you probably know, BIG is one of the several groups which advises the Department of Natural Resources on public policy concerning critical Bay issues. To insure uniformity we request that all advisory organizations use the same format for their reports. Please limit your report to only four public policy statements, including an Environmental Impact Statement for each public policy statement.

The environmental impact of each public policy should be first assessed by completing the Environmental Impact Statement Grid. A set of instructions, "Preparing the Environmental Impact Grid," along with a detailed list of "Criteria for Evaluating Environmental Impact," are also attached for your reference. Following the instructions carefully will provide for uniformity as well as ensuring a comprehensive analysis of your policies.

Please contact our office with any concerns or questions. We look forward to your report.

Enclosures: "Environmental Impact Statement Grid"
"Preparing the Environmental Impact Grid"
"Criteria for Evaluating Environmental Impact Statements"

PREPARING THE ENVIRONMENTAL IMPACT GRID

with Criteria for Evaluating Environmental Impact

1. Research. The potential negative impact of each public policy statement on the Chesapeake Bay environment must be researched. Refer to the *Data Bank* and other sources for relevant data. Discuss your ideas and data with members of your interest group.

2. Prepare an environmental impact grid. Once you have fully researched each public policy, each group should formalize its evaluation by preparing the "Environmental Impact Statement (EIS) Grid" for each of the four policy statements.

First, use the checkoff to select the specific actions (A-J) that are actual components of each public policy statement under review. To enhance decision making, refer to Section I of the *Criteria for Evaluating Environmental Impact.* Section I breaks down into subcategories each of the proposed actions that may have a negative impact on the Chesapeake Bay.

Once you have checked off the specific actions for each policy, have each interest group member vote on the level of negative impact for each specific action. Consult Section II of the *Criteria for Evaluating Chesapeake Bay Environmental Impact* before assessing the level of impact. This list of "Existing Bay Environmental Characteristics and Conditions" facilitates an examination of the possible changes that could be caused by specific proposed actions. Each group member votes according to the following procedure:

0: no impact at all
1: slight impact (some changes, but not negative ones)
2: moderate impact (quite a few changes, some of which are negative)
3: severe impact (many changes, most of which are negative)

The votes of all members are then averaged and written in the appropriate square of the grid to indicate the severity of the impact.

3. Subcommittee. After your interest group has determined the impact of all policies, send one or more representatives to convene with each of four subcommittees that consist of representatives from each of the interest groups. Each subcommittee will compile the environmental impact grids for one policy from each interest group onto one consolidated grid.

4. Prepare a consolidated environmental impact grid for the BIG Conference delegates. The subcommittee will transfer the numerical values (totals) from each of the seven interest groups onto the appropriate square of the grid transparency. Each number will be color-coded according to the following scheme:

0—7, yellow: slight impact or none
8-14, orange: moderate impact
15-21, red: severe impact

5. Mitigation of public policies. In each instance where the sum is 8 or greater, the subcommittee needs to propose ways to mitigate (or minimize) the harmful impact of the policy on the Bay environments and devise guidelines for implementation. These proposed mitigations will be reported back to all members of the BIG Conference for consideration.

Each individual then votes either to approve or to reject the mitigated policy and its EIS. A simple majority is required for approval. If not approved, the subcommittee must reconvene and work out a set of compromises acceptable to the majority of the BIG delegates. Alternated public policies not selected in Activity 4 should be consulted for ideas.

Criteria for evaluating Chesapeake Bay environmental impact

I. Proposed actions that may have a negative impact on the Chesapeake Bay environment

A. Modification of ecosystem
  1. Exotic plants or animals introduced
  2. Biological controls
  3. Modification of habitat
  4. Alteration of ground cover
  5. Alteration of ground water hydrology
  6. Alteration of drainage
  7. River control and flow modification
  8. Canalization
  9. Irrigation
  10. Weather modification
  11. Burning
  12. Surface or paving
  13. Noise and vibration

B. Land transformation and construction
  1. Urbanization
  2. Industrial sites and buildings
  3. Airports
  4. Highways and bridges
  5. Roads and trails
  6. Railroads
  7. Cables and lifts
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		1	2	3	4	5	6	7	8	9	10	11
		Modification of Ecosystem	Land Transformation And Construction	Resource Extraction	Land Use Activities	Land Alteration	Resource Renewal	Changes In Traffic	Waste Treatment And Disposal	Chemical Treatment	Accidents	Other
Policy	1											
	2											
	3											
	4											

ENVIRONMENTAL IMPACT STATEMENT (EIS) GRID— EXPANDED

		Proposed Actions having An Impact On The Chesapeake Bay Region										
		1 Modification of Ecosystem	2 Land Transformation And Construction	3 Resource Extraction	4 Land Use Activities	5 Land Alteration	6 Resource Renewal	7 Changes In Traffic	8 Waste Treatment And Disposal	9 Chemical Treatment	10 Accidents	11 Other
	Check-Off											
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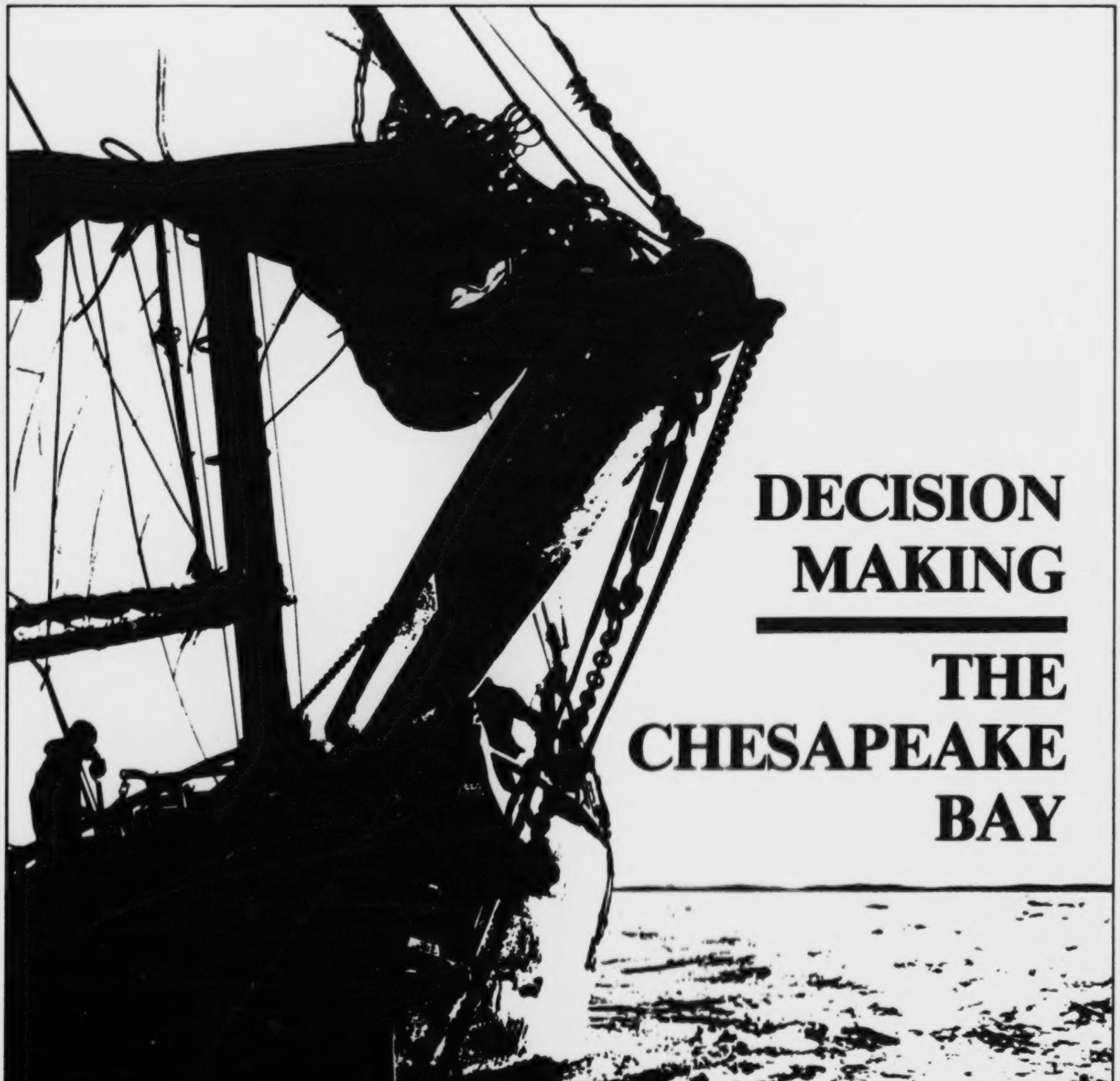
	Other M											

CHESAPEAKE BAY DATA BANK

Adapted from the U.S. Army Corps of Engineers 1977
Chesapeake Bay: Future Conditions Report



DECISION MAKING

THE CHESAPEAKE BAY

Chesapeake Bay Data Bank
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SECTION I

The Chesapeake Bay Region

ENVIRONMENTAL SETTING AND NATURAL RESOURCES

GEOLOGY

The Chesapeake Bay Region is divided into two geologic provinces–the Coastal Plain and the Piedmont Plateau. These provinces run roughly parallel to the Atlantic Ocean in similar fashion to the Bay itself and join at the Fall Line (see Figure 3). This natural division generally marks both the limit of tide as well as the head of navigation.

The Coastal Plain Province includes the Eastern Shore of Maryland and Virginia, most of Delaware, and a portion of the Western Shore. On the Eastern Shore and in portions of the Western Shore adjacent to the Bay, the Coastal Plain is largely low, featureless, and frequently marshy, with many islands and shoals sometimes extending far offshore. The Province is a gently rolling upland on the Western Shore and in the northern portions of the Eastern Shore. The Coastal Plain reaches its highest elevation in areas along its western margin.

The Coastal Plain runs primarily south-easterly-dipping, sedimentary layers such as sand, clay, marl, gravel, and diatomaceous earth resting on a base of hard crystalline rock. These layers, which can be readily seen in areas where wells have been drilled, increase in thickness towards the Continental Shelf (see Figure 4) In a few isolated areas and in locations where water has cut a deep channel, the basement rock is exposed in ridges.

The Piedmont Plateau is not, as its name implies, a plateau. It is characterized by low hills and ridges which tend to rise above the general lay of the land reaching a maximum height near the Appalachian Province on the west. Many of the stream valleys are quite narrow and steep-sided, having been cut into the hard crystalline rocks which are characteristic of the Province.

The parent material of the Piedmont Province is older than that of the Coastal Plain. The structurally complex crystalline rocks have been severely folded and subjected to great heat and pressure thereby creating metamorphic rocks.

SOILS

Soils consist of a thin layer of material made from broken and decomposed rock with added products of decaying organic matter called humus. The Study Area contains soils produced from the three major types of rock, namely igneous, metamorphic, and sedimentary. The first two types are found primarily in the Piedmont Province, whereas the Coastal Plain is composed of sediments.

Climate appears to have a definite effect on soil development. Although the Bay Area is generally characterized by a humid climate, local variations in temperature and rainfall produce some differences in soil type. Soil characteristics (texture, drainage, structure, particle size, physical composition, and degree of development) have had a strong role in determining soil usefulness. Richer, well-drained soils are more productive in terms of agriculture. Few crops can grow on soils which are poorly drained or which lack plant nutrients. Soils on the Coastal Plain are highly variable with regard to drainage characteristics and most need liming to neutralize their naturally acidic condition. Piedmont soils are medium-grained, easily tilled, and of generally higher fertility than those of the Coastal Plain. A few soils are impermeable when wet, retarding the movement of water and causing waterlogging. As a result, strong surface runoff causes serious erosion of slopes.

CLIMATE

The Chesapeake Bay Study Area is characterized by a generally moderate climate, due in a large part to the area's nearness to the Atlantic Ocean. Variations occur, however, on a local short-term basis due to the large geographical size of the Bay Area.

Precipitation within the Bay Region was studied at selected stations during a 30-year sample record from 1931 to 1960. The average for the Study Area was 44 inches per year, with geographical variations from about 40 to 46 inches per year. Snowfall, included in the precipitation totals, averaged 13 inches per year and occurred generally between November and March.

Three types of storm activity bring precipitation to the Region. The first type consists of extratropical storms or "lows" which originate to the west, either in the Rocky Mountains, Pacific Northwest, or the Gulf of Mexico. The second is tropical storm or hurricane activity which originates in the Middle Atlantic or the Caribbean Sea region. The third is thunderstorm activity which is almost always on a local scale. It is this last activity which brings about the greatest amount of local variation in precipitation in the Bay Area.

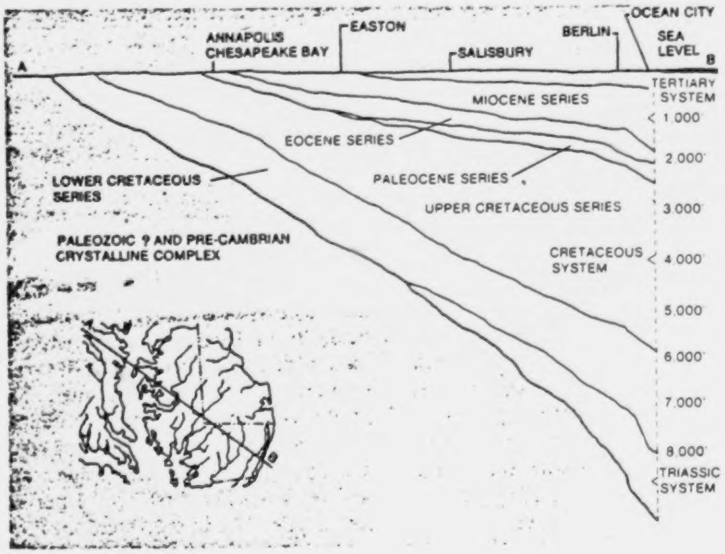
Evapotranspiration, which includes water losses due to evaporation from land and water surfaces and transpiration from plants, amounts to approximately 60 percent of the annual precipitation or about 26 inches per year. Authorities estimate an annual evaporation of 36 to 40 inches from the Bay itself.

The average temperature for the Study Area is approximately 57 degrees Fahrenheit (°F). The Bay is oriented in a north-south direction, however, and covers a wide latitudinal area, allowing wide temperature variances. As a result, the temperature at the head of the Bay averages less than 55°F, while at the mouth it averages almost 60°F,

SURFACE WATER HYDROLOGY

The source of freshwater for the Bay is runoff from a drainage basin covering about 64,160 square miles. Approximately 88 percent of this basin is drained by five major rivers, including the Susquehanna, Potomac, Rappahannock, York, and James. These five rivers average an inflow of 69,000 cubic feet per second. These river basins are subject to periodic

Figure 4: Geologic Cross-Section of the Coastal Plain Province in Maryland



seasonal changes in flow due to droughts and floods. Of these, droughts are the more geographically widespread and long-term in nature.

GROUNDWATER RESOURCES

Large reservoirs of high quality fresh-water are located in the groundwater aquifers of the Chesapeake Bay Region. Aquifers are subsurface sand and gravel-type materials with relatively high ability to conduct water. Water levels in the aquifers fluctuate according to the balance between precipitation and aquifer recharge, on the one hand, and evapotranspiration, runoff, and withdrawals on the other hand. In the Bay Area, of the average precipitation of 44 inches per year, an estimated 9 to 11 inches actually contributes to the recharge of the groundwater reservoirs.

Of the more productive aquifers in the Chesapeake Bay Area, the water-bearing formations known as the Columbia Group produce very high yields. Extensive areas on the Eastern Shore and portions of Harford and Baltimore Counties, Maryland, are the principal users. The Piney Point Formation is important in Southern Maryland, portions of Maryland's Eastern Shore and in areas near the Fall Line in Virginia. Lastly, the Potomac Group provides water to Anne Arundel, Charles, and Prince Georges Counties, Maryland and is the most important source of groundwater in the Coastal Plain of Virginia.

THE CHESAPEAKE BAY ESTUARY

The Chesapeake Bay Estuary is a mere youngster, geologically speaking. It is generally believed that the Bay was formed about 10,000 years ago, at the end of the last Ice Age, when the great glaciers melted and poured uncountable billions of gallons of water back into the world's oceans. As a result of this great influx of water, the ocean level rose several hundred feet and inundated large stretches of the coastal rivers. The ancient Susquehanna, which had drained directly into the Atlantic Ocean near what is now the mouth of the Bay, was one of these "drowned" waterways. Because the area around the old Susquehanna was characterized by relatively low relief, the estuary that was formed by this mixing of salt and freshwater covered a large geographical area but was relatively shallow. This newly formed body of water was later to be named "Chesapeake Bay." Chesapeake Bay varies from 4 to 30 miles in width and is about 200 miles long. Although the Chesapeake is the largest estuary in the United States, with a surface area of approximately 4,400 square miles, the average depth of the Bay proper is only about 28 feet and about two-thirds of the Bay is eighteen feet deep or less. There are, however, deep holes which generally occur as long narrow troughs. These troughs are thought to be the remnants of the ancient Susquehanna River valley The deepest of these holes is about 174 feet and occurs off Kent Island.

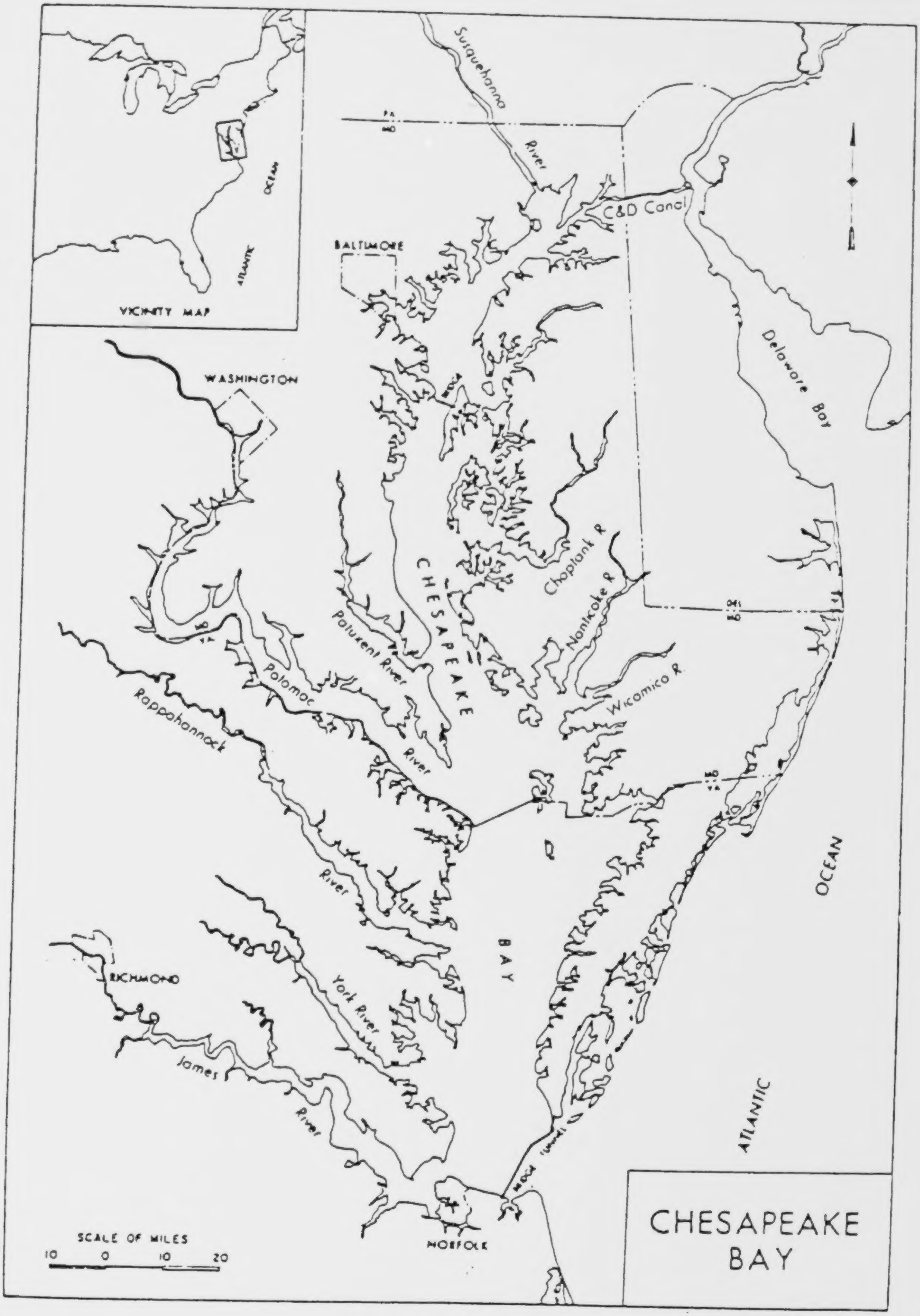
Tidal Currents:

Chesapeake Bay is a complex, dynamic system. Words like "restless," "unstable," and "unpredictable," which generally describe the young of most animal species, can also be used to describe the young estuary. The ebb and flood of the tides and the constant action of the waves are the most easy to see water movements in the Bay. Average maximum tidal currents range fro 0.5 knots to over 2 knots (1 knot equals 1 nautical mile of 6,076 feet per hour.) The average tidal fluctuation in Chesapeake Bay is small, generally between one and two feet. Except during periods of unusually high winds, waves in the Bay are relatively small, generally less than 3 feet in height.

Salinity Currents:

In addition to the tides, there is a second type of mixing, less obvious, non-tidal, two-layered circulation pattern that causes the fresh water to move down toward the sea on the surface layers, and the salty, more dense water to flow up the estuary on the bottom layers. This phenomenon is illustrated in Figure 5. The tidal currents provide some of the mixing of the two layers.

Tides and wave action (as well as other types of currents) are biologically significant in several ways. They provide mixing, transportation, and distribution of inorganic and organic nutrients. These water movements also affect the dispersion of eggs, larva, spores, gametes, and smaller advanced stages of resident plants and animals; remove waste products and bring food and oxygen to fixed bottom-dwelling organisms; and circulate chemical "clues" which aid predators in locating their prey. Tides and waves are also especially important ecologically to the intertidal zone (the shoreline area between high and low tides) of an estuary because of their wetting action which is beneficial to many plant and animal species In sheltered waters, the mixing of water by tidal and wave action is important to keep salinity and temperature more even in order not to harm some biota. The churning caused by wave action also



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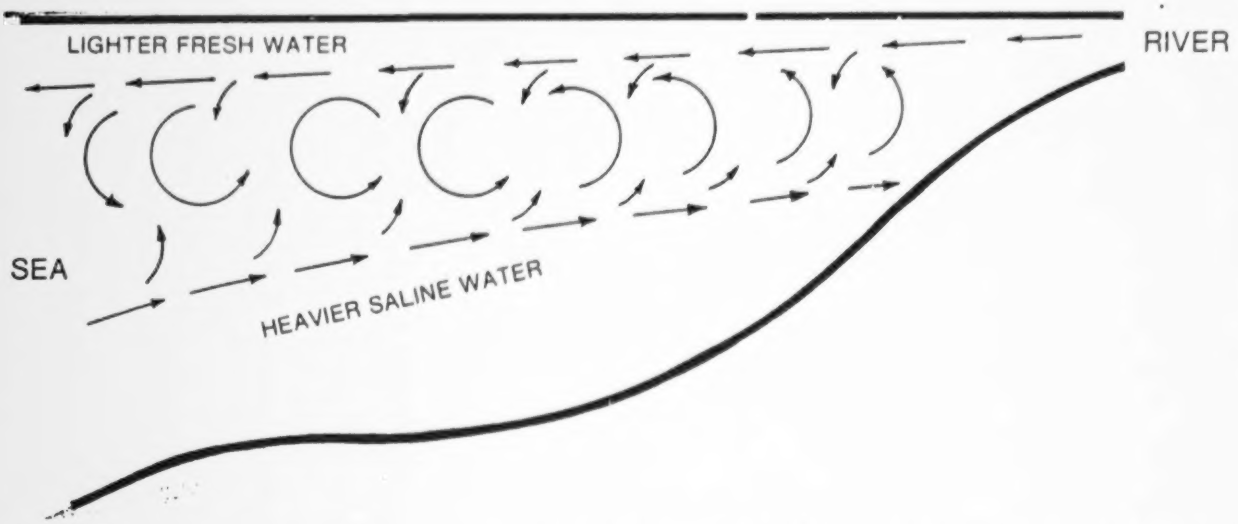
BAY

Figure 5 : Circulation in a Partially Mixed Estuary



plays a role in aeration of the waters to provide sufficient oxygen for biotic respiration.

The mixing in the estuary of sea water and freshwater creates salinity variations within the system. In Chesapeake Bay, salinities range from 33 parts per thousand at the mouth of the Bay near the ocean to near zero at the north end of the Bay and at the Fall Line of the tributaries to the Bay.

Higher salinities are generally found on the Eastern Shore than on a comparable area of the Western Shore due to the greater river inflow on the Western Shore and to the earth's rotation. Salinity patterns also vary seasonally according to the amount of freshwater inflow into the Bay system. Figure 6 illustrates these phenomena.

Due to this seasonal variation in salinity and the natural density differences between fresh and saline waters, significant non-tidal circulation often occurs within the Bay's small tributary embayments. In the spring, during the period of high freshwater inflow to the Bay, salinity in the embayments may be greater than in the Bay. Because of this salinity difference, surface water from the Bay flows into the tributaries on the surface, while the heavier, more saline bottom water from the tributaries flows into the Bay along the bottom. As Bay salinity becomes greater through summer and early fall, Bay waters flow into the bottom of the tributaries, while tributary surface waters flow into the Bay.

The variations in salinity that occur in the Bay are part of the natural estuary, and the plants and animals that live here are ordinarily able to adjust to the changes. Sudden or long changes in salinity may upset the equilibrium between organisms and their environment. Abnormal periods of freshwater inflow may alter salinities sufficiently to cause widespread damage to the ecosystem.

Dissolved Oxygen:

Dissolved oxygen is another important physical factor. Dissolved oxygen levels vary considerably both seasonally and according to depth. During the winter the Bay is high in dissolved oxygen content; since oxygen is more soluble in cold water than in warm water. With spring and higher temperatures, the dissolved oxygen content decreases. While warmer surface waters stay near saturation, in deeper waters the dissolved oxygen content becomes significantly less despite the cooler temperatures because of increasing oxygen demands (by bottom dwelling organisms and decaying organic material) and decreased vertical mixing. Through the summer, the waters below 30 feet become oxygen deficient. By early fall, as the surface waters cool and sink, vertical mixing takes place and the oxygen content at all depths begins to steadily increase until there is an almost uniform distribution of oxygen. While species vary in the level of dissolved oxygen they can withstand before respiration is affected, estuarine species in general can function in waters with dissolved oxygen levels as low as 1.0 to 2.0 mg/liter. Dissolved oxygen levels of about 5.0 mg/liter are generally considered necessary, however, to maintain a healthy environment over the long term.

Temperature:

The effects of temperature on the estuarine system are also extremely important. Since the waters of Chesapeake Bay are relatively shallow compared to the ocean, they are more affected by atmospheric temperature conditions. Generally speaking, the annual temperature range in Chesapeake Bay is between 0°C and 29°C. Because the mouth of the estuary is close to the sea, it has a relatively stable temperature as compared with the upper reaches. Some heat is required by all organisms for the functioning of bodily processes. These processes are restricted, however, to a particular temperature range. Temperatures above or below the critical range for a particular species can be fatal unless the organism is able to move out of the area. Temperature also causes variations in water density

Light:

Light is necessary for the survival of plants because of its role in photosynthesis. Turbidity, more than any other physical factor, determines the depth light will penetrate in an estuary. Turbidity is suspended material,

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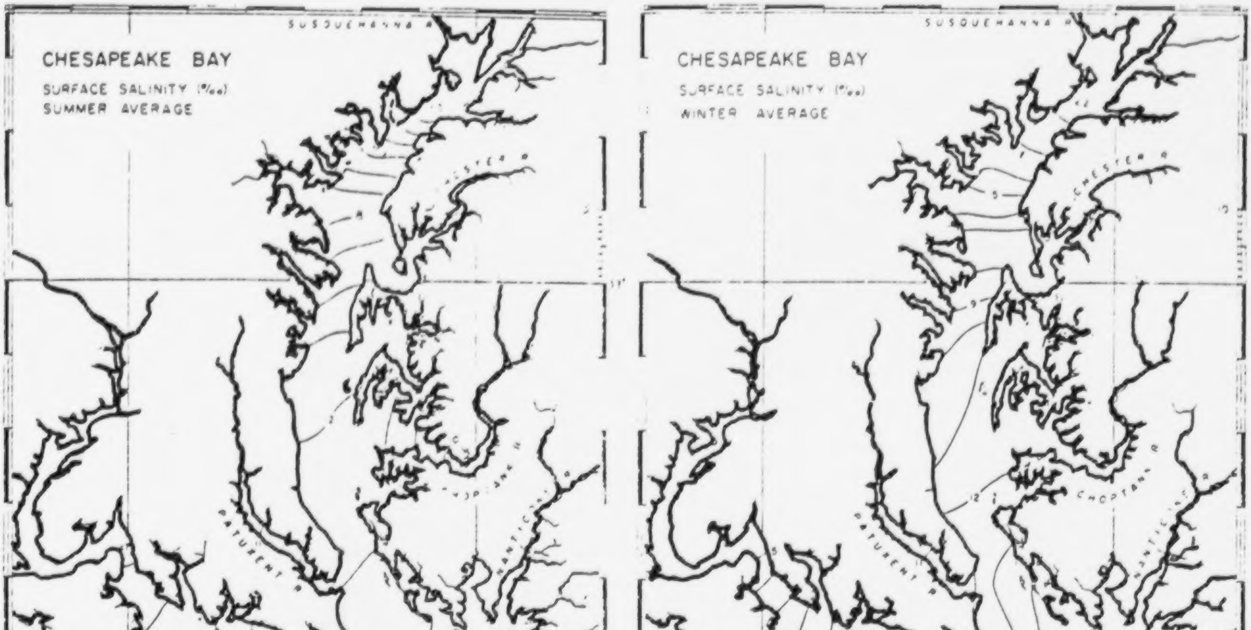
Figure 6: Geographical and Seasonal Variations in Salinities in Chesapeake Bay



mineral and/or organic in origin, which is transported through the estuary by wave action, tides, and currents. While the absence of light may be beneficial to some bottom dwelling organisms since they can come out during daylight hours and feed in relative safety, this condition limits the distribution of plant life because of the restriction of photosynthetic activity. This restriction of plant life (especially plankton in the open estuary) will reduce the benthic (i.e., bottom dwelling) and zooplankton populations which in turn will reduce fish productivity.

Nutrients:

Nutrients are the minerals essential to the normal functioning of an organism. In Chesapeake Bay, important nutrients include nitrogen, phosphorus, carbon, iron, manganese, and potassium. It is generally believed that most of the nutrients required by estuarine organisms are present in sufficient quantity in Chesapeake Bay. Excesses of some nutrients are often a more important problem than deficiencies. Excesses of nitrogen and phosphorus, for example, may cause an increase in the rate of eutrophication which, in turn, can eliminate desirable species, encourage the growth of obnoxious algae, and cause low dissolved oxygen conditions from the decay of dead organisms and other materials. Relatively little is known about the quantities of specific nutrients necessary for the healthy functioning of individual species, or more importantly, of biological communities.

While it is necessary to keep in mind the interactions of these physical and chemical variables when studying Chesapeake Bay, these parameters should not and, in fact, cannot be addressed separately. The Bay ecosystem is characterized by the dynamic interplay between many complex factors. As a simple example, the levels of salinity and temperature will both affect the metabolism of an aquatic organism. In addition, both salinity and temperature can cause a drop in the oxygen concentration in the water and thus an increase in the required respiration rate of the organism. While it is true the effects of these variables individually may be of a non-critical nature, the combined effects of the three stresses may be severe to the point of causing death. These three factors in turn, also interact with other physical and chemical variables, such as pH, carbon dioxide levels, and availability of nutrients, and numerous others. The subtle variable of time may also become critical in many cases. The important point is that the physical and chemical environment provided by Chesapeake Bay to the plants and animals is extremely complex and difficult, if not impossible, to completely understand.

THE BIOTA OF CHESAPEAKE BAY

The estuary is biologically a very special place. It is a very demanding environment because it is constantly changing. The resident plants and animals must be able to adjust to changes in physical and chemical environment. The requirement for adjustment limits the number of species of plants and animals that are able to survive and reproduce in the estuary. Despite the fact that relatively few species inhabit the Bay, the Chesapeake, like most estuaries, is an extremely productive ecosystem.

Productivity:

There are a number of reasons why estuaries are so productive. First, the circulation patterns in the area of mixing of lighter freshwater with heavier sea water in a partially mixed estuary such as Chesapeake Bay tend to create a "nutrient trap" which acts to retain and recirculate nutrients (see Figure 5). Second, water movements in the estuary do a great deal of "work" removing wastes and transporting food and nutrients enabling many organisms to maintain a productive existence which does not require the expenditure of a great deal of energy for excretion and food gathering. Third, the recycling and retention of nutrients by bottom-dwelling organisms, the effects of deeply penetrating plant roots, and the constant formation of detrital material in the wetlands create a form of "self-enriching" system. Last, estuaries benefit from a diversity of producer plant types which together provide year-round energy to the system. Chesapeake Bay has all three types of producers that power the ecosystems of our world: macrophytes (marsh and sea grasses), benthic microphytes (algae which live on or near the bottom), and phytoplankton (minute floating plants).

PRODUCERS

AQUATIC PLANTS

As implied above, certain aquatic plants are critical to the health and productivity of Chesapeake Bay. Green plants use sunlight and the inorganic nutrients in the water to produce the energy to drive the estuarine ecosystem. Thus, these plants, ranging from the microscopic algae to the larger rooted aquatics, are the *primary* producers—the first link in the aquatic food chain. Aquatic plants exist in the natural environment in many shapes, forms, and degree of specialization. They are also found in waters of widely varying physical and chemical quality.

"Phytoplankton" is a general term for aquatic plants of both fresh and saline waters which are characteristically free-floating and microscopic. The most important of the phytoplankton are the green algaes, diatoms, and dinoflagellates. The population of these organisms is represented by relatively few species, but when they do occur, they are present in tremendous numbers. Phytoplankton are the principal photosynthetic producers in the marine, estuarine, and freshwater environments, and will grow in the water column to any depth that light will penetrate. Blue-green algae are another type of phytoplankton organism which are not generally considered to be of importance in aquatic productivity, but are best known for the nuisance conditions caused when their growth occurs in excess. Huge populations, or blooms, of these organisms located near the surface of the water reduce the sunlight available to bottom-dwelling organisms. The blooms can also give off objectionable odors, clog industrial and municipal water intakes, and generally cause nuisance conditions.

Macrophytes are, as the Greek roots of the word indicate, "large plants."

Unlike the freely floating, or only weakly motile, and minute phytoplankton, the macrophytic aquatic plants are generally either rooted or otherwise fastened in some manner to the bottom. All of the forms require sunlight to conduct photosynthesis and most have defined leaflets which grow either entirely submerged, floating on the surface of the water, or out of the water with leaf surfaces in direct contact with the atmosphere.

The distribution of Macrophytes ranges from entirely freshwater to the open ocean. These types of plants are not only important as food and habitat for fish and wildlife, but they are also important in the recovery of nutrients from deep sediments.

The "Biota" section of the *Chesapeake Bay Existing Conditions Report* and Appendices 14 and 15 of the *Chesapeake Bay Future Conditions Report* include a more detailed discussion of aquatic plants – their types and distribution, importance in the ecosystem, and the problems associated with them.

CONSUMERS:

FISH AND WILDLIFE

The energy supplied to the ecosystem by the green plants of the Bay must be made available in some manner to the meat-eating predators, including man, which are higher in the food chain. This vital link is filled by many different varieties of organisms such as zooplankton and various species of worms, shellfish, crabs, and finfish. Zooplankton include small crustaceans such as copepods, the larva of most of the estuarine fishes and shellfishes, several shrimp-like species, and other animal forms that generally float with the currents and tides. Phytoplankton and plant detritus (along with adsorbed bacteria, fungi, protozoa, and micro-algae) are consumed directly by the zooplankton and other larger aquatic species.

If man through his activity interrupts an established energy flow in the environment, he may cause energy losses to the system as well as other detrimental biological effects. Man's activities, for example, may cause the loss of a detritus producing area (e.g., a stand of saltmarsh cordgrass) resulting in a decline of the organisms which primarily feed on detritus. A loss of this nature directly affects the next higher trophic level, thereby starting a chain reaction throughout the food web. Generally, in estuaries, there is a great deal of dependence of larger organisms on a few key smaller organisms that utilize detritus and micro-algae for food.

Like the aquatic plant communities, the aquatic animal communities are not spread evenly throughout the Bay. Although the entire Estuary serves as nursery and primary habitat for finfish, spawning areas are concentrated in the areas of low salinity and freshwater in the Upper Bay and corresponding portions of the major tributaries. The northern part of Chesapeake Bay, including the Chesapeake and Delaware Canal, is probably the largest of all spawning areas in the Bay. This area plus the upper portions of the Potomac, York, Rappahannock, James, and Patuxent Rivers, represent about 90 percent of the anadromous fish (i.e., those which ascend rivers from the sea to reproduce) spawning grounds in the Chesapeake Bay Region. The Bay serves as a spawning and nursery ground for fish caught from Maine to North Carolina. Some of the fish that use the Bay as a nursery include striped bass, weakfish, shad, alewife, blueback herring, croaker, menhaden and kingfish (see Figure 7).

Oysters are abundant in many parts of the Estuary. The numerous small bays, coves, and inlets between the Chester and Nanticoke Rivers along the Eastern Shore and the lower portions of the Patuxent, Potomac, York, Rappahannock, and James Rivers account for approximately 90 percent of the annual harvest of oysters.

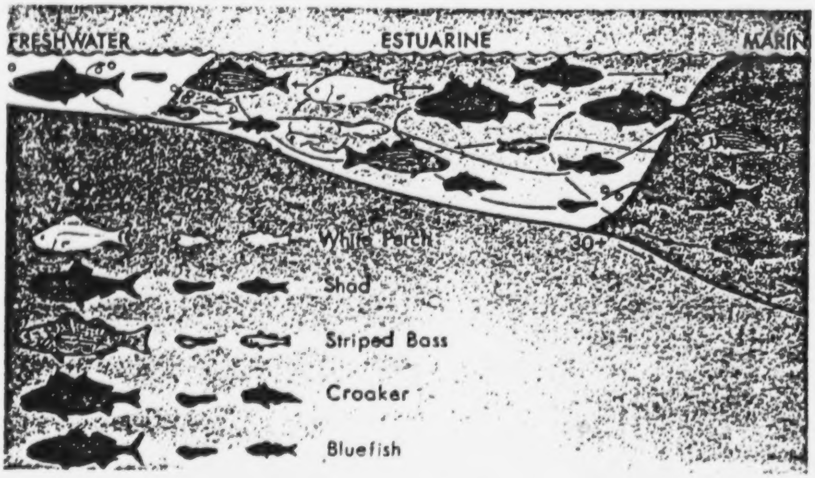
Some species of Chesapeake Bay fish and shellfish thrive in the saltier waters of the Estuary. The mouth of the Chesapeake, an area of high salinity, is the major blue crab spawning area in the Bay and its tributaries.

In addition to Chesapeake Bay's large resources of finfish and shellfish, the marshes and woodlands in the Area provide many thousands of acres of natural habitat for a variety of waterfowl, other birds, reptiles, amphibians, and mammals.

Waterfowl:

Chesapeake Bay is the constricted neck in the gigantic funnel pattern that forms the Atlantic Flyway. Most of the waterfowl reared in the area between the western shore of Hudson Bay and Greenland spend some time in the marshes of the Bay and its tributaries during their migrations. Good wintering areas adjacent to preferred upland feeding grounds attract more than 75 percent of the wintering population of Atlantic Flyway Canada geese. The marshes

Figure 7: Fishes: Their Use of the Estuary



and grain fields of the Delmarva Peninsula are particularly attractive to Canada geese and grain-feeding swans, mallards, and black ducks. The Susquehanna Flats, located at the head of the Bay, support huge flocks of American widgeon in the early fall, while several species of diving ducks, including canvasback, redhead, ringneck, and scaup, winter throughout Chesapeake Bay. About half of the 80,000 whistling swans in North America winter on the small estuaries in or around the Bay. While the Chesapeake is primarily a wintering ground for birds that nest further north, several species of waterfowl, including the black duck, blue-winged teal, and wood duck, find suitable nesting and brood-raising habitat in the Bay Region.

Other birds:

In addition to waterfowl, many other species of birds are found in the Bay Area. Some rely primarily on wetlands for their food and other habitat requirements. These include rails, various sparrows, marsh wrens, red-winged blackbirds, snipe, sandpipers, plovers, marsh hawk, shorteared owl, herons, egrets, gulls, terns, oyster catcher, and curlews. Many of the above species are insectivores, feeding on grasshoppers, caterpillars, beetles, flies, and mosquitoes, while others feed on seeds, frogs, snakes, fish, and shellfish. There are numerous other birds which rely more heavily on the wooded uplands and agricultural lands for providing their basic habitat and food requirements. Among these species are many game birds, including wild turkey, mourning dove, bobwhite quail, woodcock, and pheasant. It should be emphasized that some of these species require both an upland and a wetland habitat. Modest populations of ospreys and American bald eagles also inhabit the Bay Region.

Mammals:

The Chesapeake Bay Region is also home for most of the common mammals which are native to the coastal Mid-Atlantic Region. The interspersion of forest and farmland and the proximity of shore and wetland areas form the basis for a great variety of ecological systems. The abundance of food such as mast and grain crops and the high quality cover vegetation found on the wooded uplands and agricultural lands support good populations of white-tailed deer, cottontail rabbit, red fox, gray fox, gray squirrel, woodchuck, opossum, and skunk. The various vegetation types found in wetland areas provide indispensible natural habitat requirements for beaver, otter, mink, muskrat, marsh rabbit, and nutria. In addition, there are numerous species of small mammals, reptiles, and amphibians which inhabit the Study Area and are integral parts of both the upland and wetland food cycles.

IMPORTANT PLANT AND ANIMAL ORGANISMS

A survey of prominent Bay Area scientists was conducted to determine the most important plant and animal species based on economic, biological, and social criteria. For example, a species would qualify as an "important species" if it were either a commercial species, a species pursued for sport, a prominent species important for energy transfer to organisms higher in the food chain, a mammal or bird protected by Federal law, or if it caused harm to other species important to man. The common names of the 124 species and genera identified according to these criteria are presented in Table 3.

PLANT AND ANIMAL COMMUNITIES

Although the plants and animals of Chesapeake Bay have been treated separately in the previous discussion, in the real world they are bound together in communities. Bay communities are important because of the complex interactions between inhabiting organisms, both plant and animal, and between one community and another. In the "eelgrass" community, for example, the organic detritus formed by eelgrass, plus the microorganisms adsorbed on it, represent the main energy source for animals living in the community and for animals outside the community to which detritus is transported. In addition, eelgrass performs the following physical and biological functions:

1. It provides a habitat for a wide variety of organisms

2. It is utilized as a nursery ground by fish

3. It is a food source for ducks and brant

4. The plant physically acts as a stabilizing factor for bottom sediments, which allows greater animal diversity

5. It plays a role in reducing turbidity and erosion in coastal bays.

Appendix 15 presents more detailed information on the eelgrass community as well as the "oyster" community, two of the most important in the Chesapeake Bay System, and the physical and chemical parameters which affect them.

It is evident from the preceding discussion that Chesapeake Bay is an almost incomprehensibly complex physical and biological system. When the human element is added, the complexities and interrelationships become even more involved.

THE PEOPLE

POPULATION CHARACTERISTICS

When Captain John Smith first explored the Chesapeake in 1608, it was an estuary which had yet to feel the impact of man to any significant extent. But, even before Captain Smith's voyage, people had settled on the shores of the Bay drawn by its plentiful supplies of fish and game. These settlements were inhabited by Assateagues, Nanticoke, Susquehannock, and Choptank Indians. It was the Indian that provided the names for many promontories of land and water courses. The relatively few wastes generated by the Indians were easily assimilated by the natural cleansing action of the Bay and its tributaries. Later, more and more people moved into the Bay Region, attracted first by a soil and climate favorable to the growth of tobacco, and later by the development of major manufacturing and transportation centers as well as the founding of the Nation's capital at Washington, D.C. By 1974, 366 years after Captain Smith's voyage up the

TABLE 3
IMPORTANT CHESAPEAKE BAY PLANT AND ANIMAL ORGANISMS – COMMON NAMES

Algae

Blue-green alga
**Diatom (4 genera)
Dinoflagellate (3 species)
Sea lettuce
Green alga
Red alga

Vascular Plants (Marsh and aquatic)

*Widgeongrass
Saltmarsh Cordgrass
Eelgrass
Horned pondweed
Wild rice
Cattails
Pondweeds
Arrow-arum
Wild celery

Cnidaria

*Stinging nettle
**Hydroid

Ctenophora (comb jellies)

Comb jelly (2 species)

Platyhelminthes (flatworms)

Flatworm

Annelida (Worms)

**Bloodworm
Clam worm
Polychaete worm (4 genera)
Oligochaete worm

Mollusca (Shellfish)

Eelgrass snail
Oyster drill
Marsh periwinkle
Hooked mussel
Ribbed mussel
Oyster
Hard shell clam

Mollusca (Shellfish) (Cont.)

**Coot clam
**Brackish water clam
Balthic macoma
Stout razor clam
Razor clam
*Soft shell clam
Asiatic clam

Arthropoda (Crabs, shrimp, and other crustaceans)

Barnacle
*Copepod (2 genera)
Opposum shrimp
Cumacean
Isopod (2 species)
Amphipod (5 genera)
Sand flea
**Grass shrimp
**Sand shrimp
**Xanthid crab (2 species)
Blue crab

Urochordata

Sea squirt

Pisces (Fish)

Cownose ray
Eel
**Shad, herring
Menhaden
Anchovy
Variegated minnow
Catfish, bullheads
Hogchoker
**Killifish
Silverside
**White perch
Striped bass
Black sea bass
Weakfish
**Spot
Blenny
Goby
Harvestfish
Flounder

Pisces (Fish) (Cont.)

**Northern puffer
Oyster toadfish

Reptiles

**Snapping turtle
**Diamond-backed terrapin

Aves (Birds)

Horned grebe
Cattle egret
Great blue heron
Glossy ibis
**Whistling swan
**Canada goose
Wood duck
**Black duck
Canvasback
Lesser scaup
**Bufflehead
**Osprey
Clapper rail
Virginia rail
American coot
American woodcock
Common snipe
Semipalmated sandpiper
Laughing gull
Herring gull
Great black-backed gull
Forster's tern
Least tern

Mammalia (Mammals)

Beaver
Muskrat
Mink
Otter
Raccoon
White-tailed deer

Endangered Species

Shortnose sturgeon
Atlantic sturgeon
Maryland darter
Southern bald eagle
American peregrine falcon
Ipswich sparrow
Delmarva fox squirrel

*Life histories discussed in the "Biota" Chapter of the *Chesapeake Bay Existing Conditions Report.*

**Life histories discussed in the "Biota" Appendix of the *Chesapeake Bay Future Conditions Report.*

Bay, there were 8.2 million people living in the Bay Region.

During Colonial times, the Chesapeake Bay Region was one of the primary growth centers of the New World. However, after the decline of the Region's tobacco industry in the 19th century, population growth began to lag. This period of relative stagnation lasted until World War II when large increases in Federal spending (especially on defense) stimulated employment and population growth within all the economic subregions. As shown in Table 4, the areas around Washington, D.C. and Norfolk, Virginia, have experienced especially high rates of growth since World War II. Over half of the total population growth in the Bay Region between the time of the Jamestown settlement to the present occurred during the 1940-1970 period. Population in the Region has increased since the 1970 Census considerably.

The majority of the inhabitants of the Chesapeake Bay Area are concentrated in relatively small areas in and around the major cities. People have tended to move out of the inner cities and rural counties and into the suburban counties. Thirty-five of the 76 counties and major independent cities in the Area experienced a net out-migration during the 1960-1970 period. On the other hand, most of the suburban counties experienced growth rates in excess of 30 percent and in-migrations of at least 10 percent of their 1960 population. In the Bay Region as a whole, net in-migration accounted for about one-third of the 1.5 million increase in population during the decade of the 1960's. Most of this in-migration was in response to large increases in employment opportunities in the Bay Region.

In 1970, there were approximately 3.3 million people employed in the Study Area. About 91 percent of these worked in one of the Region's seven SMSA's. During the 1960–1970 period, total employment increased by about three-quarters of a million jobs or approximately 30 percent. The National gain during the same period was 19.5 percent.

Compared to the Nation as a whole, the Bay Region has a lower proportion of workers in the blue-collar industries, such as manufacturing and mining, and a higher proportion in the white-collar industries, such as public administration and services. Due to a higher percentage of white collar workers the Study Area has had consistently lower unemployment rates over the last several decades than the Nation as a whole. Also contributing to these relatively stable employment levels are the large numbers of workers whose jobs depended on relatively consistent Federal government spending.

Per capita income in the Bay Area was $3,694 in 1969, which was about 9 percent higher than the National figure. Median family income levels

TABLE 4
POPULATION GROWTH IN THE CHESAPEAKE BAY STUDY AREA DURING THE 1940–1970 PERIOD BY ECONOMIC SUBREGION

Study Area Portions of BEA Economic Regions*	1940 Population	1970 Population	Absolute Change	Percentage Change
Baltimore, Maryland	1,481,179	2,481,402	+ 1,000,223	+ 67.5
Washington, D. C.	1,086,262	3,040,371	+ 1,954,109	+179.9
Richmond, Virginia	437,103	728,946	+ 291,843	+ 66.8
Norfolk-Portsmouth, Va.	467,229	1,121,856	+ 654,627	+140.1
Wilmington, Del. SMSA	248,243	499,493	+ 251,250	+101.2
Total Study Area	3,720,016	7,872,068	+ 4,152,052	+111.6
Total United States	132,165,129	203,211,926	+71,046,797	+ 53.8

Source: U.S. Census Data
*See Figure 1

ranged from $16,710 in Montgomery County, Maryland, (one of the highest in the Nation), to $4,778 in Northampton County, Virginia. As shown in Table 5, there was a significantly higher proportion of families in the over $15,000 income bracket and fewer families whose incomes were below the poverty level in the Bay Area than in the Nation.

ECONOMIC SECTORS

MANUFACTURING

Generally speaking, the Chesapeake Bay Region has a lower proportion of its workers employed in heavy water-impacting industries than in the Nation as a whole (see Figure 8). For example, manufacturing activities in the Bay Region employed some 524,000 workers in 1970, or about 16 percent of the total employment in the Study Area. This figure was significantly lower than the National figure of approximately 25 percent. In addition, manufacturing employment in the Bay Region grew by 6 percent during the 1960–1970 period, which was well below the National growth rate of 13 percent.

Despite the fact that the manufacturing sector was not as important to the economy of the Study Area as in the Nation as a whole, the sector still has a great deal of significance. First, the navigation channels in Chesapeake Bay are used by many Area manufacturers as a means of shipping raw materials to their factories and finished products to market. Second, many manufacturing firms use water in their production process, usually for cleaning or cooling purposes. This water is often returned to the Bay system untreated or only partially treated. Industrial wastes are sometimes toxic as the recent kepone incident in the James River demonstrates.

As Figure 9 indicates, in addition to the fact that there is a relatively low proportion of workers in manufacturing in the Bay Region, the majority of the manufacturing industries which are located in the Area are not considered to be major water users (i.e., chemicals, pulp and paper, metals, petroleum refinery, and food and kindred products). The heavy water users that do exist are generally concentrated in the Upper Bay around Baltimore and in the Wilmington, Delaware SMSA. Employment in the chemical and metal industries is centered around Baltimore, Wilmington, and Richmond. Food and kindred products employment is concentrated on the Eastern Shore, in the Washington SMSA, and in Norfolk. The only major pulp and paper mill in the Bay Region is located at West Point, Virginia. There is also currently only one major petroleum refinery in the Region which is located at Yorktown, Virginia. Other significant concentrations of manufacturing industries are: printing and publishing and the two machinery categories in the Washington area, transportation equipment around Norfolk-Portsmouth, and tobacco processing in the Richmond SMSA. A more detailed discussion of industrial activity in the Bay Region is provided in Appendix 3 – "Economic and Social Profile".

PUBLIC ADMINISTRATION

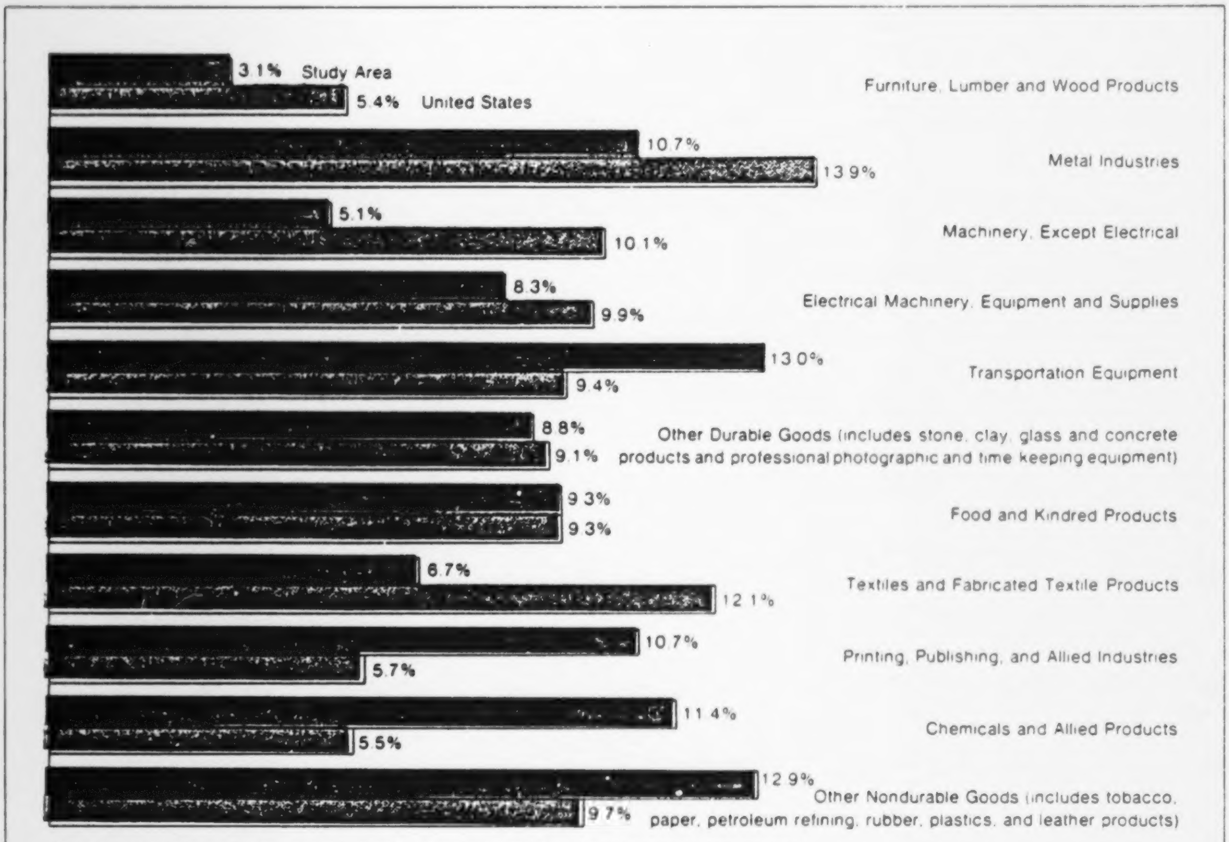
The public administration sector, which includes civilian workers in the Federal, State, and local governments, is extremely important to the economy of the Bay Region. In 1970, this sector employed approximately 475,000 people or about 14 percent of the total workers. This is significantly higher than the National average of 5 percent. Employment in this sector grew 36 percent during the 1960–1970 decade, very close to the 37 percent rate of growth for the Nation.

Although the public administration sector ranked only fourth in total employment in the Study Area, the sector is far more important to the Region's economy than these employment figures indicate. First, earnings are higher than average in this sector. This has helped to stimulate other sectors of the economy, especially the retail trade and service industries. Second, the Federal portion of the public administration sector can be thought of as a "basic" industry since it exports its "product" (public ser-

TABLE 5
FAMILY INCOME DISTRIBUTION FOR THE CHESAPEAKE BAY STUDY AREA AND THE UNITED STATES, 1969

	Percent Below Poverty Level	"Middle" Income Families	Percent Above $15,000
Study Area	11.2	61.3	27.5
United States	12.2	68.6	19.2

Figure 9: Manufacturing Employment for the Chespeake Bay Study Area and United States, 1970

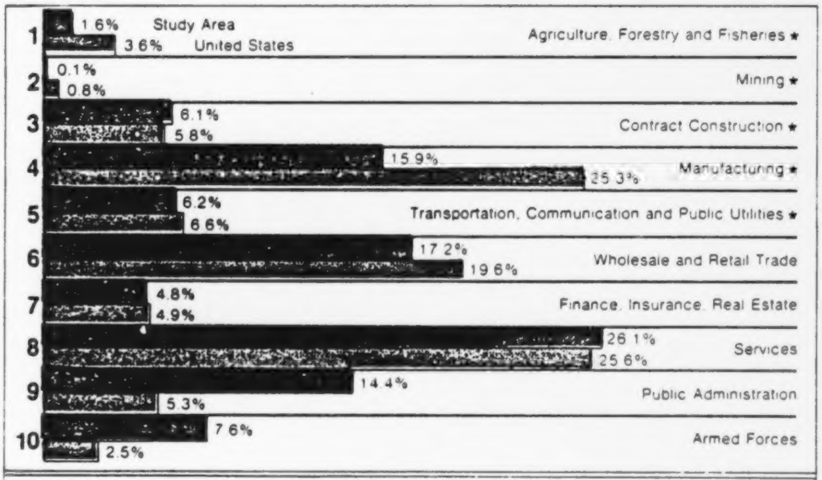


Source: U.S. Census of Population: 1970, "General Social and Economic Characteristics."

vices) to the entire Nation, thereby, bringing money into the Region and creating jobs.

The bulk of the total Public Administration employment in the Study Area (almost 66 percent) is located in the Washington, D.C. area. Other concentrations of workers are in the Richmond, Virginia, vicinity, throughout much of the Baltimore, Maryland, SMSA, and in the Norfolk-Portsmouth area.

The public administration sector can be considered a "clean" industry from a water resources viewpoint. There are no special requirements for water for either processing or transportation purposes. However, fast-growing industries, such as the public administration sector, with its tremendous drawing capacity for workers and their fam-



★ Denotes Heavy Water-Impacting Industries

Source: U.S. Census Data

Figure 8: Employment by Economic Sectors, Chesapeake Bay Study Area and United States, 1970

ilies, can often cause rates of population growth that tax the ability of local government to provide services such as water supply and sewerage. The Washington, D.C. area with its until recently overloaded waste treatment plants and its increasingly inadequate water supply is a good example of this.

AGRICULTURE

Although less than 2 percent of the total workers in the Chesapeake Bay Region are employed in the agricultural sector (i.e., the actual planting, cultivation, and harvesting of raw agricultural goods), these activities have a great deal of impact on the Area's economy and water and land resources. In 1969 (the latest data available at this writing), the value of all farm products sold by commercial farms in the Bay Region was approximately $589 million. Approximately 87 percent of the developed land in the Bay Region is used for agricultural purposes. Poor farming techniques, both in the past and present, have resulted in the extensive erosion of valuable soils which, in turn, has caused the siltation of many of the Bay's waterways. Run-off from fields sprayed with chemical fertilizers add large quantities of nutrients to the waterways. This practice has resulted in an increase in the amounts of undesirable algae and other vegetation in some waters, thereby decreasing the amounts of available oxygen in the water and, in extreme cases, causing fish kills. In addition, the use of insecticides in agricultural areas has caused significant damage to fish and wildlife populations in the Bay Region with the classic examples being the effects of DDT on the bald eagle and osprey populations.

FISHERIES

Just as the Indians and early settlers harvested the Bay's plentiful supplies of finfish, shellfish, and crabs, modern day watermen harvest and market large quantities of the Chesapeake's living treasures. In 1973, commercial landings of shellfish and finfish totaled 565 million pounds with a value at the dock of approximately $47.9 million. This catch amounted to an average of 200 pounds per surface acre of water. In addition, sport landings of finfish and shellfish in recent years have been estimated to be as large as the commercial catch for some species. However, even when the value of the sports fishing catch is added to the commercial catch value, the total is a very small percentage of the value of agricultural products, for example, and almost negligible when compared to value added in the manufacturing sector. On the other hand, the fisheries and watermen of Chesapeake Bay add a generous amount of regional color and tradition to the "way of life" in the Bay Region. These benefits are difficult, if not impossible, to measure.

Because agricultural products and seafood are often perishable, they are usually processed in close proximity to where they are harvested. As a result, the agricultural and seafood harvesting sectors in the Bay Region support locally important food processing plants.

ARMED FORCES

Still another important source of employment for residents of the Bay Region is the Armed Forces. In 1970, there were approximately 250,000 members of the Armed Forces stationed within the Study Area, representing almost 8 percent of the total employment. This percentage was significantly higher than the National figure of 2.5 percent. The cities of Norfolk and Virginia Beach in the Hampton Roads area and Anne Arundel, Prince Georges, and Fairfax counties in the Baltimore and Washington, D.C., areas contained the largest numbers of military personnel.

Construction Activitites Can Have Severe Impacts.

CONSTRUCTION

The construction sector in the Bay Region employed approximately 200,000 people in 1970. Construction activities have had a great deal of impact on the water resources of the Bay Region. Much of the disturbed soil on construction sites becomes sediment in streams and rivers. This silt can adversely affect fish and wildlife populations, clog navigation channels, increase the costs of treatment for city and industrial water supplies, make water-based recreation less enjoyable, and generally lower the aesthetic quality of a waterway. Unfortunately, the areas in the Region with the most construction activity are the same areas in which there are already significant industrial and residential strains on the Bay.

OTHER SECTORS

The remaining Bay Region workers, which account for more than one-half of the total, are employed in one of the following sectors:

1. Wholesale and retail trade
2. Transportation, communications, and public utilities
3. Finance, insurance, and real estate
4. Services

"These jobs are generally 'supportive' of the economic sectors discussed previously. With the exception of the transportation and public utilities sectors which are discussed in more detail in the "Navigation," "Electric Power," "Water Supply," and "Water Quality" Appendices, they do not have a significant impact on the water resources of the Region. Many of these activities, however, exist in the Region because of the proximity of the Chesapeake Bay resource. For example, the Bay's land and water resources allow for the development of certain "regionally-unique" entertainment and recreation services which help to expand the service sector. These include such activities as private bathing beaches, pleasure and fishing boat rentals, and the operation of seafood restaurants serving regional specialities. Some of the other activities (e.g., finance, insurance, retail trade, real estate, and certain services) exist in the Bay Region because it is an area which is characterized by higher than average incomes and population growth rates. The location of the Nation's capitol in the Area also attracts many workers in these sectors due to the regulatory functions of the Federal Government and the desirability of companies in the regulated industries to maintain offices in the Washington area.

ECONOMIC AND DEMOGRAPHIC PROJECTIONS

OBERS SERIES C

The base projections used in the future needs analysis for most of the Appendices of the "Future Conditions Report" are based on the Series C OBERS projections of population, income, earnings, and manufacturing output prepared by the Department of Commerce and the Department of Agriculture. A special set of projections coinciding with the Chesapeake Bay Study Area and the subregions as delineated in Figure 1 was prepared by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. An explanation of the methodology used to prepare the OBERS projections and the special disaggregation by BEA is contained in Appendix 3, "An Economic and Social Profile." Figure 10 illustrates the great potential for growth that lies in the Chesapeake Bay Region.

The bulk of the total population and employment growth (about 52 percent in each category) is expected to take place in the Study Area portion of the Washington, D.C. Economic Area. This area is projected to experience population and employment growth rates of about 143 percent during the 1970–2020 period. The Richmond subregion and the Wilmington SMSA are also expected to grow at a faster rate than the Study Area as a whole with rates of 113 percent and 123 percent, respectively. On the other hand, the Baltimore and Norfolk-Portsmouth subregions are projected to grow at significantly lower rates with figures of 85 percent and 45 percent.

Real per capita income in the Study Area is projected to remain slightly above the National average through the projection period. Table 6 presents projections of population and per capita income by subregion.

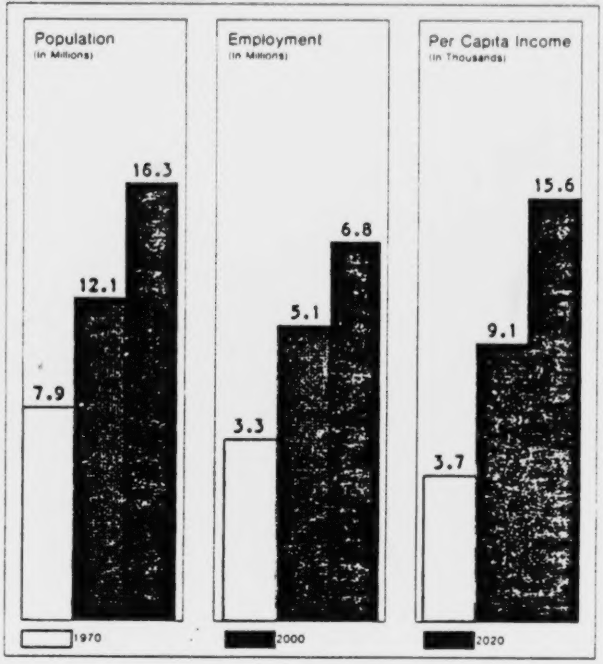
One of the major driving forces behind the significant increases in population and income outlined above will be major increases in manufacturing output. As shown in Table 7, manufacturing output in the Chesapeake Bay Region is expected to increase by 563 percent. However, the proportion of total output accounted for by the heavy water-impacting industries as a group (i.e., Metals, Petroleum Refining, Food and Kindred Products, Chemicals, and Paper and Allied Products) is expected to decline slightly from 56.8 percent in 1969 to 54.3 percent in 2020. In addition, the manufacturing sector is expected to continue to account for a significantly lower portion of total employment and income in the Bay Region than in the United States.

OBERS SERIES E

Since the initiation of the future conditions phase of the Chesapeake Bay Study, another set of baseline projections derived from more recent economic and demographic data was prepared and released by BEA. These new projections, called the "Series E" OBERS projections, must be considered by all Federal agencies engaged in water resource planning as directed by the Water Resource Council. The basic differences between the assumptions made in preparing the Series C and Series E projections are shown in Table 8 and are discussed in more detail in Appendix 3 – "Economic and Social Profile." The Series E population projection of 14.1 million people for the total Study Area in the year 2020 is approximately 13.5 percent less than the Series C estimate for the same year. The Series E projections for the Study Area for 1980 and 2000 are also lower than the Series C projections for the same years by 4.5 percent and 7.3 percent, respectively. In addition, the Series E population projections for almost all the subregions are lower than the comparable Series C projections.

Recently released estimates of 1975 population by county prepared by the U.S. Bureau of the Census allow a comparison of actual population trends in the Chesapeake Bay Study Area with those trends that would be expected under the Series C and Series E OBERS projections. The 1975 population estimate for the entire Bay Region is approximately 370,000 less than the Series C and 162,000 less than Series E interpolated estimates. However, seven of the thirteen Study Area subregions had 1975 populations which were greater than either the Series C or Series E estimates. Much of

Figure 10: Population and Economic Projections for Chesapeake Bay Region to 2020



the discrepancy in the total Bay Region estimates can be explained by a significant overestimate by both Series C and Series E of population growth in the Washington, D.C. SMSA. When population data for the Washington, D.C. SMSA is subtracted from the Bay Region totals, the remainder for the Region falls between the Series C and Series E estimates.

Based on the preceding analysis, it can be concluded that the applicability of estimates of future resource demands based on OBERS Series C or Series E baseline projections depends on the subregion of interest. It should be emphasized, however, that 1970–75 trends mây not be indicative of trends to be expected during the entire 1970–2020 projection period.

SENSITIVITY ANALYSIS

The most fundamental assumption made in preparing the projections of future demands on Chesapeake Bay presented in the *Chesapeake Bay Future Conditions Report* is that the Series C OBERS baseline projections of population, income, and manufacturing activity accurately reflect future trends in the Chesapeake Bay Region. However, in order to evaluate the impact on the resource of the Series E baseline projections, a "Sensitivity Analysis" section of each Appendix dealing with a resource use activity was prepared. These sections present future demands based on Series E baseline projections which can be compared to the Series C based projections of future demands. In addition, the sensitivity of future demands to changes in other parameters critical to the projection methodology was also evaluated. The findings of these analyses are summarized in this volume and a more detailed discussion is provided in the appropriate appendices.

TABLE 6

SERIES C PROJECTIONS OF POPULATION, PER CAPITA INCOME, AND TOTAL PERSONAL INCOME BY CHESAPEAKE BAY SUBREGION (IN CONSTANT 1967 DOLLARS)

	1969		1980		2000		2020	
	Population	Per Capita Income	Population (% Increase)[1]	Per Capita Income (% Increase)	Population (% Increase)	Per Capita Income (% Increase)	Population (% Increase)	Per Capita Income (% Increase)
Baltimore, Md.	2,463.3	$3,579	2,877.6 (16.8)	$4,912 (37.3)	3,714.0 (50.8)	$8,556 (139.0)	4,596.3 (86.6)	$14,769 (312.7)
Washington, D.C.	2,985.5	3,977	3,695.0 (23.76)	5,653 (42.1)	5,314.3 (78.0)	9,534 (139.7)	7,397.2 (144.4)	15,612 (292.6)
Richmond, Va.	727.5	3,454	871.8 (19.8)	4,828 (39.8)	1,180.1 (62.2)	8,290 (140.0)	1,555.0 (113.7)	14,184 (310.7)
Norfolk-Portsmouth, Va.	1,107.6	3,046	1,216.0 (9.8)	4,331 (42.2)	1,429.6 (29.1)	7,615 (150.0)	1,656.4 (49.6)	13,186 (332.9)
Wilmington, Del. SMSA	492.1	4,169	612.5 (24.7)	5,804 (39.2)	851.4 (73.0)	9,634 (131.0)	1,115.7 (126.7)	16,142 (287.2)
STUDY AREA TOTAL	7,776.0	$3,682	9,272.9 (19.3)	$5,182 (40.7)	12,489.4 (60.6)	$8,913 (142.1)	16,320.6 (109.9)	$15,030 (308.2)

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[1] All percentage changes are calculated from 1969.

TABLE 7
MANUFACTURING OUTPUT FOR CHESAPEAKE BAY REGION (IN MILLIONS OF 1967 DOLLARS) BY INDUSTRY, 1969 AND PROJECTED, BASED ON OBERS SERIES C

	1969	2000		2020	
	Output (1)	Output	Percent Increase (2)	Output	Percent Increase (2)
Lumber and Wood Products	154.8	433.4	180.0	807.4	421.6
Metals	977.4	2,279.9	133.3	4,095.0	319.0
Machinery, Except Electrical	233.0	835.8	258.7	1,885.9	709.4
Electrical Machinery	331.3	1,595.5	381.6	4,092.6	1,135.3
Transportation Equipment	815.1	2,534.4	210.9	4,979.7	510.9
Petroleum Refining	57.3	165.4	188.6	301.2	425.6
Food and Kindred Products	747.4	1,795.1	140.2	3,150.4	321.5
Textiles and Textile Products	229.8	657.4	186.0	1,230.3	435.4
Printing and Publishing	445.2	1,428.3	220.8	2,930.8	558.3
Chemicals	1,856.4	6,989.8	276.5	15,298.5	724.1
Paper and Allied Products	215.6	712.5	230.5	1,549.7	618.8
Other Manufacturing	719.3	2,207.7	206.9	4,614.2	541.5
TOTAL	6,782.6	21,635.2	219.0	44,935.7	562.5

(1) Output in the form of "gross product originating" which is defined as that portion of GNP originating in a specific industry.
(2) Percent change measured from base year (1969).

TABLE 8
A COMPARISON OF OBERS SERIES C AND SERIES E PROJECTIONS

Item	Series C	Series E
Growth of Population	Fertility rate of 2,800 children per 1,000 women	Gradual decline of fertility rate from 2,800 to the "replacement fertility rate" of 2,100 children per 1,000 women.
Military Establishment	Projects a decline to 2.07 million people by 1975 and thereafter a constant.	Projects a decline to 1.57 million persons by 1975 and thereafter a constant (due to smaller military establishment and the resultant smaller need for equipment and supplies a significantly slow rate of growth in the defense-related manufacturing industries is anticipated).
Hours Worked Per Year	Hours worked per employee per year are projected to decline at 0.25 percent per year.	Hours worked per employee per year are projected to decline at 0.35 percent per year.
Product Per Man-Hour	Projected to increase 3.0 percent per year.	Projected to increase 2.9 percent per year.
Earnings Per Worker	Earnings per worker in the individual industries at the national level are projected to converge toward the combined rate for all industries more slowly in the Series E projections than in the Series C projections.	
Employed Population	Projected to increase from 40 to 41 percent of the total population.	Projected to be between 43 and 45 percent of the total population (higher percentages with the E Series reflects expected higher participation rates by women).

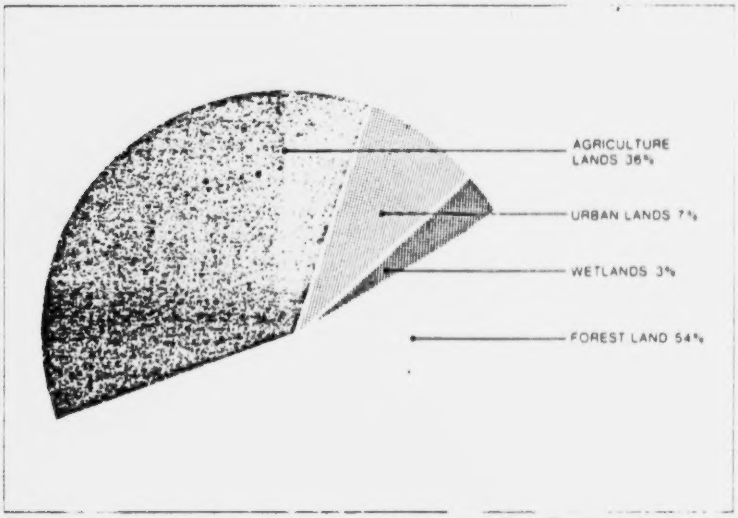

Figure 11: Major Land Use Types - Chesapeake Bay Region

LAND USE

The development of the land in the Chesapeake Bay Region began when the first group of Indians wandered into the Area thousands of years ago and established a village. Since then, virtually all of the vast expanse of virgin forest which existed at the time and thousands of acres of wetlands have been cut, drained, or filled by more recent settlers. The original purpose of this development was to provide land for the cultivation of tobacco and wheat. High tobacco and wheat prices created an almost insatiable demand for land. As the productivity of the soil decreased after producing several years of crops, the land was abandoned and new land was cleared. The abandoned land returned to woodlands. During the Nineteenth and Twentiest Centuries, factories, residences, port facilities, commercial establishments, and other physical manifestations of an increasingly industrialized society replaced many of the agricultural lands and second-growth woodlands. The following sections present a discussion of existing and future land use and related problems, as well as some alternative means of satisfying the identified needs.

EXISTING LAND USE

For the purposes of this analysis, existing land use information for the Chesapeake Bay area was developed using remote sensing data obtained from high altitude aerial photography taken in 1970. These data were supplied by the U.S. Geological Survey (USGS) and are part of the Central Atlantic Regional Ecological Test Site (CARETS) project. Plates 4-1, 4-2, and 4-3 in Appendix 4, "Water-Related Land Resources" show the type and general distribution of the major land use activities in the area covered by the CARETS project (about 95 percent of the "Bay Region"). Based on the CARETS data, estimates of land use in the Chesapeake Bay Region were developed. These are presented in Figure 11.

a. *Urban Land:* About 43 percent of the Bay Region is considered to be developed (i.e., urban plus agricultural lands). Of the 43 percent developed, 83 percent is in agricultural uses and only 17 percent is considered urban. Urban land uses are concentrated around the principal urban centers located near the head of tide on the major tributaries of the Western Shore. Many smaller urban centers are found scattered throughout the Study Area, some serving as small ports, retail and wholesale trade centers, or political centers such as State capitals or county seats. Industrial, institutional, and military reservations (of which the Bay Region has many) are also included as urban lands. Industrial activities include a variety of uses ranging from those involving the design, assembly, finishing, and packaging of light products to heavy manufacturing activities such as steel, pulp, or lumber milling, electric power generating, oil refining, and chemical processing. Most frequently, industries are found in or adjacent to urban areas where good transportation facilities and ample manpower are available.

b. *Agricultural Land:* Land used for the production of farm commodities comprises over one-third of the Chesapeake Bay Region's land area. As such, it constitutes the second largest land use type in the Study Area, second only to forest lands. The major physical factors governing the use of land for agricultural purposes include rainfall, growing season, soil, drainage, temperature, evaporation, and the amount of sunshine. Other factors such as proximity to markets, tax laws, land tenure arrangements, and farming practices also influence the intensity and type of agriculture. The major agricultural areas in the Bay Region are located on the Eastern Shore of Maryland, Virginia and Delaware, in the rural portions of the Baltimore SMSA, in the northwestern portion of the Washington SMSA, and around Virginia Beach, Virginia.

c. *Forestlands:* Forestlands occupy more area in the Bay Region than any other land use type, approximately 54 percent. Since it was not possible to distinguish between public and private forestlands on the remote sensing data, both are included in Figure 11. The Virginia portion of the Study Area accounts for almost two-thirds of the total forest land. The Southern Maryland area also has a high proportion of woodlands.

d. *Wetlands:* The wetlands of the Bay Region, although accounting for only 3 percent of the total land area, are of crucial importance to the ecosystem of the Bay. Wetlands consist of seasonally flooded basins and flats, meadows, marshes, and bogs.

Each of the States in the Bay Area has legally defined its wetlands. Maryland defines its wetlands as all land under the navigable waters of the State below the mean high tide which is affected by the regular rise and fall of the tide. Virginia wetlands are defined as all that land lying between mean low water and an elevation above mean low water equal to the factor 1.5 times the tide range. Delaware defines its wetlands as those lands above the mean low water elevation including any bank, marsh, swamp, meadow, flat or other land subject to tidal action and including those areas connected to tidal waters whose surface is at or below an elevation of two feet above local mean high tide.

All of the counties of the Bay Region have some wetland areas of varying types and sizes, although it should be emphasized that not all wetland types are equally valuable to the ecosystem. The ecological value of a particular wetland area depends on such factors as the type of dominant plant, flushing action in the area which affects the availability of nutrients to the aquatic community, and the intensity of use of the wetland as habitat. The major concentration of wetland areas in the Chesapeake Bay system is found along the lower Eastern Shore.

e. *Archaeological, Historic, and Natural Areas of Significance:* The primary prehistoric archaeological resources within the Study Area are associated with Indian artifacts. The numerous Indian tribes which inhabited what is now Maryland, Virginia, and Delaware left much evidence of their existence in the form of clay pottery and stone artifacts. Thousands of archaeological sites have been recorded in the Region but due to monetary and manpower limitations, it is believed that only a fraction of the archaeological resources have been discovered. Almost the entire shoreline of the Bay and its tributaries are thought to be potential archaeological sites. Plates 4-7, 4-8, and 4-9 in Appendix 4, "Water-Related Land Resources," show the existing and potential archaeological sites in the Chesapeake Bay Region.

The large number of historic sites in the Bay Region provides proof of the Region's historic significance and its fundamental role in the development of the Nation. Many of the sites relate to the earliest colonial settlements, the winning of National independence, the founding of the Union, the Civil War struggle, and the lives of National leaders. Within the Study Area are found such historically important items as the U.S. Frigate Constellation, the nation's oldest warship; the Annapolis Historic District, an early colonial port and capital of the U.S. during a short period in 1783–1784; Stratford Hall, home of Robert E. Lee, Commander of the Confederate Armies; Mt. Vernon, home of the first President of the United States; numerous battlefield sites commemorating some of the most important Civil War and Revolutionary War battles; the Jamestown National Historic Site, first permanent English colony in North America; Williamsburg Historic District, capital of the Virginia Colony during much of the eighteenth century and an important social and cultural center of the English colonies during that period; and numerous historic and commemorative sites in the Washington, D.C. area. Appendix 4, Attachment A, lists nearly 800 properties within the Bay Area included on the *National Register of Historic Places.*

There are certain other areas of the Bay Region which are of special importance for their ecological or natural significance. Many of these have been identified, and in many cases are being protected. Included in these types of areas are: especially important wetlands or other floral habitats, faunal habitats (especially for threatened or endangered species), and naturally scenic areas. At present, there are twenty properties within the Study Area designated as National refuges or related properties (such as the Patuxent National Wildlife Research Center). The primary purpose of these refuges is to protect wildlife including certain endangered and threatened species. Biological research is conducted at a number of these facilities while limited hunting is offered at some. Within the Study Area, there are also 68 State fish and wildlife management areas and related properties including game farms, sanctuaries, and preserves. Plates 4-16, 4-17, and 4-18 of Appendix 4 show the Federal and State conservation and management areas in the Chesapeake Bay Region.

The Center for Natural Areas, Ecology Program, Smithsonian Institution, has also shown concern for the Bay's significant ecological and natural areas. In 1974, this group prepared a report entitled "Natural Areas of the Chesapeake Bay Region: Ecological Priorities," which surveys the endangered flora and fauna of the Bay Region and the areas of significant ecological importance.

Maryland and Virginia have initiated programs to identify and designate certain rivers within their boundaries as scenic rivers. The Virginia Commission of Outdoor Recreation was directed by the General Assembly to study the Commonwealth's rivers for the purpose of designating those which should be protected to provide for the enjoyment of present and future generations. As a result of this survey, the Commission recommended establishment of a state scenic river system in 1970. Local and State land use controls are to be imposed along with numerous other standards to guarantee the protection of those rivers designated as scenic. The Maryland Legislature also recognized that certain rivers within the State plus their adjacent land areas possess outstanding scenic, fish, wildlife, and other recreational values. The State adopted a policy which protects the water quality of those rivers and fulfills vital conservation purposes by promoting the wise use of land resources within the scenic river system. Use is limited to "horseback riding, natural and geological interpretation, scenic appreciation, and other programs through which the general public can appreciate and enjoy the value of these areas as scenic and wild rivers in a setting of natural solitude." Table 4-28 of Appendix 4 lists the designated scenic and potential scenic rivers of the Chesapeake Bay Region.

FUTURE LAND USE

The expected future distribution of land uses in the Bay Region was developed from the relevant county, municipal, and regional comprehensive land and water use plans. Plates 4-4, 4-5, and 4-6 in Appendix 4 present this information based on a consistent land use classification system. Numerical estimates of future acreages for urban, agricultural, and forest lands are presented in the following sections.

a. *Urban:* The portion of land in residential uses in the urban areas can be expected to increase at roughly the same rate as population growth if the assumption is made that population densities will remain at about the same level over the projection period. This means that the demand for residential lands will increase by approximately 18 percent by 1980, 59 percent by the year 2000, and about 107 percent by 2020.

As discussed in Chapter II, manufacturing output in the Chesapeake Bay Region is projected to increase at a rate of approximately 560 percent between 1969 and 2020. It is not valid, however, to assume that land needed for industrial purposes will also increase by this percentage since output per worker and per unit of land will probably increase during this period. If the assumption is made that the productivity of land increases at about the same rate as the productivity of workers, about 3.0 percent annually, then the land needed for industrial purposes can be expected to increase by 28 percent over the 1969 acreage by 2000, and by 50 percent by 2020.

b. *Agricultural:* The projections of land in crops and miscellaneous farm uses (woodland on farms is included in the "Forests" category) in the Chesapeake Bay Region were derived from OBERS projections of these land use categories by State. Appendix 4 describes in greater detail the methodology used in determining projections of agricultural land use. The amount of acreage in cropland and miscellaneous farmland is projected to show a steady decline during the projection period as shown in Table 9.

c. *Forests:* Projections of private commercial forest lands were also disaggregated from OBERS projections by State. As indicated in Table 10, the projected acreage of private commercial forest land within the Study Area is expected to decline steadily over the projection period. It should be noted that public forest lands are not included in these figures.

d. *Wetlands:* Although no projections were prepared of future wetland acreages, it can be stated with a high degree of confidence that the demand for shoreline lands for such uses as marinas, vacation homes, or port facilities will increase in the future. However, more stringent Federal and State restrictions on the development or degradation of wetland areas along with a growing awareness of the ecological and economic importance of wetlands are likely to at least slow down the historic rate of wetlands destruction in the Chesapeake Bay Region. An Executive Order signed by President Carter in 1977 sets more stringent guidelines governing Federal activities in wetland areas.

PROBLEMS AND CONFLICTS

As shown in the previous section, the expected increases in the demand for residential and industrial land in the

TABLE 9
PROJECTED CROPLAND AND MISCELLANEOUS FARMLAND* FOR THE CHESAPEAKE BAY REGION
(THOUSANDS OF ACRES)

State	1980	2000	2020
Delaware	544	519	493
Maryland	1,614	1,493	1,362
Virginia	1,481	1,305	1,147
TOTAL CHESAPEAKE BAY REGION	3,639	3,317	3,002

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*Miscellaneous farmland includes pasture, range, lands occupied by buildings, roads, ditches ponds, and wastelands.

TABLE 10
PROJECTED ACRES OF PRIVATE COMMERCIAL FOREST LAND FOR THE CHESAPEAKE BAY STUDY AREA

	1980	2000	2020
Delaware	365,560	355,940	346,320
Maryland	1,983,456	1,935,296	1,860,654
Virginia	4,533,673	4,222,717	3,900,972
TOTAL:	6,882,689	6,513,953	6,107,946

Chesapeake Bay Region is approximately offset by decreases in agricultural and forest use (each projected separately). The locations in which these land use changes will occur, however, has not been clearly defined. The conflict, then, is not one of enough land for development, but it is where the development should take place. Often the best agricultural lands or the most productive forests are also desirable for urban development. Without proper planning, other areas of special ecological, historical, or archaeological significance will continue to be destroyed in the wake of "urban sprawl."

SENSITIVITY ANALYSIS

Comparison of future land use demands computed using OBERS Series C projections, with those computed using Series E, yields no significant differences except in the demand for residential land. Residential land requirements obtained through Series E population projections were approximately 5 percent less than the Series C based projections for 1980, 7 percent less for 2000, and about 13 percent less in 2020. Due to a lack of data, it was not possible to develop Series E based projections of industrial land demands.

MEANS TO SATISFY THE NEEDS

There are numerous measures available to provide for the orderly development and proper use of the water-related land resources of the Chesapeake Bay Region. The following section presents a general discussion of these measures. A more thorough analysis is available in Appendix 4.

a. *Local Land Use Controls:* Zoning of geographical areas can be used to guide future land use decisions so as to encourage those which complement each other and preclude those which conflict. It has been used effectively to segregate residential uses from commercial and industrial uses, for example, as well as to preserve recreational areas, parks, conservation areas, and natural resources of special significance, and to control the development of flood-prone areas. Subdivision regulations can be used to preserve open or agricultural lands by restricting land use to low-density, multiple-acre uses. Tax policies have also proven useful in controlling land use development. Through preferential tax treatment, or public land acquisition policies, the preservation and development of agricultural lands, open space areas, and conservation zones can be encouraged.

A few local governments within the Study Area have attempted to curb development and thereby control land use within their jurisdiction through "sewer moratoriums." Such measures prohibit the construction of new sewer systems or the extension of existing systems. Some of these same counties and towns have effectively used the provision of water and sewer services to guide growth to areas that have been planned for development. Such measures represent a primary means for a region to plan growth in accord with its public service and environmental capabilities.

b. *State Land Use Controls:* Although the final decisions for land use proceedings remain the discretion of the local authorities, the various States in the Study Area have recognized, to varying degrees, that local subdivisions often do not have adequate jurisdiction or, if the land use issue has more than a local impact, proper authority to provide desirable management of resources. The States have the legislative authority to intervene in such circumstances. The wetland laws of Maryland, Virginia, and Delaware are a good example of this type of authority. These laws seek to preserve the wetlands and to prevent their degradation taking ecological, economic, developmental, recreational, and aesthetic values into account.

c. *Federal Land Use Controls:* One of the most important Federal land resource management programs is the National Oceanic and Atmospheric Administration's Coastal Zone Management Program (CZMP). Through this program, the Federal Government assists the States in developing a plan for the management of land and water areas in the coastal zone. State programs seek to achieve wise use of land and water resources of the coastal zone and must give full consideration to ecological, cultural, historic, recreational, and esthetic values as well as needs for economic development. The Federal CZMP provides grants to the coastal states and territories to support two-thirds of the cost of developing a state program, four-fifths of the cost of administering the program, and one-half of the cost of acquiring, developing, and operating estuarine sanctuaries for research and educational purposes.

There are certain other Federal programs or items of legislation which either directly or indirectly address the control of land use. Examples include the National Environmental Policy Act of 1970, the Rivers and Harbors Act of 1899 (which makes it illegal to allow any refuse to be introduced into a navigable waterway), and the Water Pollution Control Act Amendments of 1972.

Future Federal legislation may very well be aimed at establishing a nationwide land use planning and policy process. Since 1970, various land use control bills have been introduced in Congress but none have, as yet, been passed by both Houses. Although each bill has been different from the others, all would have established some form of National land use policy. Each bill has been quite controversial and has met with great public opposition. If this opposition is alleviated, it is possible that some form of National land use policy will be adopted.

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SECTION II

Water Resource Problems and Needs

As population, industrial output, incomes, and leisure time in the Chesapeake Bay Region increase in the future, the demands on the Area's water and related land resources will, most certainly, also increase. The following sections of this chapter present a discussion of the current status and problems, as well as projected future demands, supplies, and needs for the following Chesapeake Bay water and related land resource use categories.

1. Water Supply
2. Water Quality
3. Outdoor Recreation

WATER SUPPLY

CURRENT STATUS

The vast quantities of surface and ground water available in the Chesapeake Bay watershed are a primary source of water supply for numerous communities and industries. As shown on Figure 12, more than 2,460 million gallons of water per day (mgd) are used by citites, industries, rural areas, and farmers in feeding livestock and poultry and in irrigating. Many millions of gallons more water are used in generating electrical power.

Of this 2,460 mgd, approximately 900 mgd is brackish water used in industrial processes, 122 mgd is reused municipal wastewater, and the remainder is freshwater from ground and surface sources. Industrial and municipal systems accounted for over 96 percent of total water use.

MUNICIPAL WATER SUPPLY

Of the Bay Area's 7.9 million residents, approximately 6.5 million, or 82 percent, are served by public water supply systems. These systems range in size from those serving as few as 20 persons in small developments to large municipal systems serving commercial, institutional and industrial establishments and millions of individuals.

Municipal water uses encompass a variety of needs which may be generally classified as domestic, commercial, industrial, institutional, and public. Domestic uses include those of the household, e.g., food preparation, washing, lawn watering, and sanitation. Uses within the commercial category include restaurants, hotels, laundries, and car washes; while hospitals and schools are classified as institutional. Public uses include fire protection, street cleaning, and water use in government buildings and institutions. Manufacturing industries use water for processing, boiler feed, cooling, and sanitary purposes. Depending on the extent and composition of a city's industrial component and the tendency for local industry to pay for and use public water, a municipal system's industrial water use component may vary radically. There are public water supply systems in the Bay Area that supply no water to industry and others that support an industrial component that may exceed 50 percent of the total use.

Table 11 shows the population served and the average water use in each of the 49 WSA's in the Chesapeake Bay Area. Water use rates vary widely between the subregions, ranging from about 100 gallons per/capita per day (gpcd) to nearly 190 gpcd. For the entire Bay Region, water use averaged 139 gpcd in 1970. The importance of the metropolitan areas is evidenced by the fact that the Baltimore and Washington SMSA's account for 74 percent of the population and 77 percent of the total water used among the Region's WSA's. More detailed data for each community is presented in Table 5-1 of Appendix 5.

Use rates exceeding 150 gpcd occur in a number of cities: Cambridge, Crisfield, Salisbury, Leonardtown, Seaford, Baltimore, Washington, Hopewell, and Williamsburg. These high use rates can be attributed to several factors, not always consistent from system to system. For example, Hopewell's astonishing 689 gpcd is due to an estimated 22 mgd supplied to several large industries. Significant industrial uses also contribute to the high rates at Cambridge, Salisbury, and Baltimore, while institutional, military demands and tourism contribute to the higher than normal use at Williamsburg, Virginia. The extensive government activity and array of public facilities in Washington, D.C., cause use rates in the Washington area to be

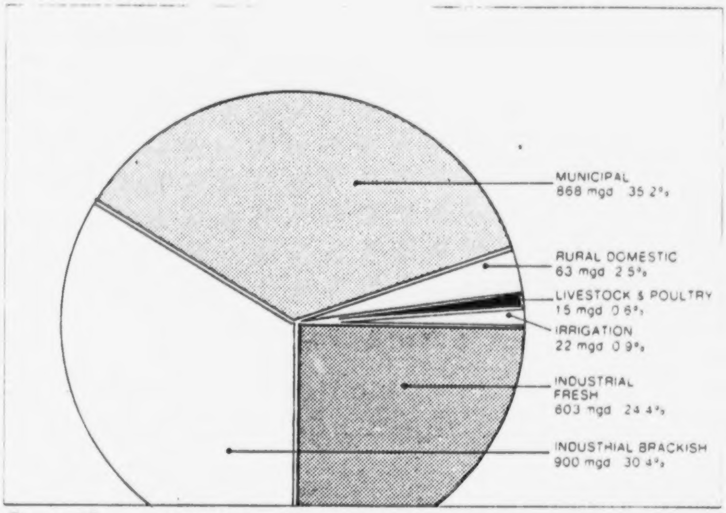

Figure 12: Average Water Use in the Chesapeake Bay Region by Type

among the highest in the Bay Area. Another component of water use in most systems is leakage. In Crisfield, Maryland, for example, losses due to leakage constitute an unusually high 25 percent of the overall use. Most of the public systems have use rates that would be expected from an average amount of residential use and mix of other uses (approximately 80 to 150 gpcd).

In addition to the Water Service Areas (i.e., those systems defined previously as serving a population of 2,500 or greater), a large number of smaller public systems exist in the Bay Area. Slightly less than one-half million people are served by these small systems. In 1970, they provided approximately 37 mgd or about 4 percent of the total water use by centrally-supplied systems. A large portion of this demand occurred in the suburban counties adjacent to areas served by the larger systems.

INDUSTRIAL WATER USE

Industrial (i.e., manufacturing) water use in 1970 was inventoried by the Bureau of Domestic Commerce (BDC), U.S. Department of Commerce. The results of this inventory are presented in Table 12. The term gross use (G) includes all water actually used in a particular process, including that quantity recirculated. Intake (I) represents the actual withdrawal from the water body plus purchases. The consumption category (C) includes all water lost to evaporation and water incorporated into final products. Discharge (D) is merely the difference between intake and consumption (I-C). The final column lists the percent of the gross use that is recycled water [(G-I)/G]. As shown in Table 12, industries in the Baltimore SMSA, the Richmond and Petersburg SMSA's and the non-SMSA portion of the Norfolk-Portsmouth Economic Area (Subregion 22-3) account for approximately 86 percent of gross water use and about 82 percent of the total intake of water in the Bay Region. In addition, 99 percent of the total water intake of 1,615 mgd was used by only 3 percent of the approximately 5,800 manufacturing establishments in the Bay Region.

In addition to the concentration of water use among a relatively small number of plants, there is also a concentration of water use within particular types of industries. In the Chesapeake Bay Region, 82 percent of the gross water use is accounted for by three groups of industries: paper and allied products, chemicals and allied products, and primary metals (see Table 13).

In many industrial processes, significant decreases in water supply withdrawals could be realized if the recycling of wastewater was more widely used. The tendency of an industry to recirculate water, however, usually depends ultimately on economics. Water will be reused in a particular situation if the costs of recovery and recirculation are less than costs associated with the development of additional sources. In locations where water of acceptable quality is scarce or where the cost of treating wastewater is high, recirculation may be attractive. Conversely, in areas with plentiful supplies of high quality water or where wastewater treatment costs are low reuse is usually uneconomical.

A measure of the degree to which recirculation technology is utilized in each subregion is shown in the final column of Table 12, and for each major type of industry in Table 13. In the Bay Region the best recycling efficiency occurs in the paper industry in which 88.7 percent of the gross water used is recycled. In other words, nearly nine times as much water would be needed from the river, or other source, if recirculation was not practiced—645 vs. 73 mgd. The petroleum industry recycles least, primarily due to the once-through use of brackish water for cooling. However, National figures for the petroleum industry indicate recirculation rates at least 10-fold that in Chesapeake Bay.

The importance of brackish water in the Chesapeake Bay Area as a source of industrial water supply is evident from the information in Table 14. The total quantity of brackish water used was 899 mgd or 56 percent of all withdrawals by Bay Region manufacturers in 1970. Approximately 37 percent of industrial withdrawals was freshwater from ground or surface sources and the remainder was reused municipal wastewater.

RURAL DOMESTIC

Rural domestic water supplies are required to serve the needs of persons that live in rural locations and that are not served by central water supply systems. Of the almost 1.4 million who lived in rural areas in 1970, about 7 percent resided on farms. The non-farm component of the population includes persons that reside in the suburbs of the major metropolitan areas such as Baltimore, Washington, D.C., and Richmond. In fact, perhaps

TABLE 11
MUNICIPAL WATER USE IN 1970 BY CHESAPEAKE BAY SUBREGION

	Subregion	Population Served	Average Use, Mgd	Per capita Use, GPCD
17-1	Baltimore, Md. SMSA	1,673,820	260.3	156
17-2	Maryland Eastern Shore*	73,270	13.8	188
17-3	Virginia Eastern Shore	NO LARGE SYSTEMS		
17-4	Delaware Non-SMSA**	5,540	0.8	153
18-1	Washington, D.C. SMSA	2,726,500	382.2	140
18-2	Southern Maryland	22,500	2.2	97
18-3	Virginia Non-SMSA	19,530	2.6	133
21-1	Richmond-Petersburg-Colonial Heights SMSA's	501,690	74.6	149
21-2	Virginia Non-SMSA	2,600	0.3	100
22-1	Newport News-Hampton SMSA	263,260	27.3	104
22-2	Norfolk-Portsmouth SMSA	633,640	66.2	104
22-3	Virginia Non-SMSA	37,210	4.6	123
	BAY REGION TOTAL	5,959,560	831.2	139

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* Includes Cecil County, Maryland.

** Includes Sussex County, Delaware, only.

surprisingly, the two major areas in terms of rural domestic water use are the Baltimore and Washington SMSA's, comprising 40 percent of the total rural domestic use in 1970.

The total water use for rural domestic purposes amounted to approximately 63.1 mgd in 1970. This has been rising rapidly since 1950 due to an increasing percentage of homes being served by in-house plumbing and running water. Homes with running water characteristically use 5 to 6 times the amount used in a home without these same conveniences. In 1970, approximately 80 percent of the rural domestic population resided in homes equipped with running water and these persons consumed about 95 percent of the total rural domestic supply. The rural domestic water demand comprises less than 3 percent of all water use in the Chesapeake Bay Region.

LIVESTOCK AND POULTRY

Water supply for livestock and poultry is required for two purposes—one, to sustain the resident farm animals and two, to produce livestock and poultry products for the market place. The livestock category includes animals such as beef cattle, dairy cows, sheep, hogs, and horses. Poultry includes chickens that are raised either for market or egg production, and turkeys.

In the Chesapeake Bay Region, livestock and poultry water consumption amounted to 14.7 mgd in 1967, or less than 1 percent of all uses Bay-wide.

Easily the largest component of livestock and poultry water use was cattle and milk cows, which, despite an overall decline in the number of animals during the previous 20 years, used 55 percent of all water used by poultry and livestock in 1969. During this same period water consumption per animal has more than doubled due to the increased stringency of sanitation codes and increased milk production per milk cow.

Water use has increased in other categories as well. Broiler chickens, which have increased in numbers since 1950 by 160 percent, utilized 28 percent of the poultry and livestock water supply in 1969. Hogs and pigs accounted for an additional 9 percent. Declines since 1950 in absolute numbers as well as water use have

TABLE 12
INDUSTRIAL WATER USE IN THE CHESAPEAKE BAY REGION, 1970, mgd

	Subregion	Gross Use (G)	Intake (I)	Consumption (C)	Discharge (D)	Percent Recycled*
17-1	Baltimore, Md. SMSA	1,226.1	990.7	43.7	947.0	19.2
17-2	Maryland Eastern Shore	35.5	34.8	0.9	33.9	1.9
17-3	Virginia Eastern Shore	2.6	2.3	0.2	2.1	11.5
17-4	Delaware Non-SMSA	82.7	65.6	1.9	63.7	20.7
18-1	Washington, D.C. SMSA	5.4	4.7	0.2	4.5	13.0
18-2	Southern Maryland	0.8	0.8	0.1	0.7	0.0
18-3	Virginia Non-SMSA	32.9	27.4	1.8	25.6	16.7
21-1	Richmond-Petersburg-Colonial Heights SMSA's	400.5	286.8	14.0	272.8	28.4
21-2	Virginia Non-SMSA	52.4	26.5	5.0	21.5	49.4
22-1	Newport News-Hampton SMSA	114.9	100.2	0.7	99.5	12.8
22-2	Norfolk-Portsmouth SMSA	32.3	25.3	1.3	24.0	21.7
22-3	Virginia Non-SMSA	621.8	50.4	4.8	45.6	91.9
	TOTAL BAY REGION:	2,607.9	1,615.5	74.6	1,540.9	38.1

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*Calculated by $\frac{G - I}{G}$

TABLE 13
WATER USE IN MANUFACTURING, BY INDUSTRIAL SECTOR, CHESAPEAKE BAY REGION, mgd, 1970

Sector	Gross Use	Intake	Consumption	Discharge	Percent Recycled
Food & Kindred Products	79.7	74.3	5.6	68.7	6.8
Paper & Allied Products	644.8	72.8	7.6	65.2	88.7
Chemicals	402.5	328.1	14.5	313.6	18.5
Petroleum	81.6	76.3	0.7	75.6	6.5
Primary Metals	1,094.6	882.3	35.1	879.2	19.4
Other Manufacturing	304.7	181.7	11.1	165.0	40.0
TOTAL	2,607.9	1,615.5	74.6	1,535.3	38.1

occurred only for sheep and horses.

Most of the livestock and poultry water use is concentrated on the Delmarva Peninsula and in portions of the Baltimore and Washington SMSA's. Poultry water use predominates on the Eastern Shore, while dairy cow production is a significant source of water demand around the SMSA's. In the southern Virginia portion of the Study Area, hogs and pigs are an important source of water demand in the livestock and poultry water use category.

IRRIGATION

The amount of water used for irrigation purposes varies greatly from year to year, depending on climatological conditions and crop patterns. Because of the generally moderate levels of precipitation (i.e., about 40 inches per year), the demand for irrigated land in the Study Area is not nearly as great as in the Southwestern or Great Plains areas of the United States. In 1969, irrigation water use amounted to 8 billion gallons in the Study Area, an increase of 18 percent over the 1964 figure. Only about 2.0 percent of the total land in crops in the Chesapeake Bay Region was irrigated in 1969. The use of water for irrigation purposes is concentrated on the Delmarva Peninsula. This area accounts for about 79 percent of the total irrigated water use in the Chesapeake Bay Region.

The major irrigated crops, in terms of acreages, were field corn (6 percent), other field crops (30 percent), vegetables (52 percent), and nursery and other crops (8 percent). According to the Soil Conservation Service (SCS), U.S. Department of Agriculture, over two million acres of farm land in the Study Area are potentially irrigable although about two-thirds would require additional treatment measures such as land leveling or drainage.

EXISTING PROBLEMS AND CONFLICTS

Provision of water for the people, industries, and farms of the Bay Area is not accomplished without the water supplier encountering certain problems. Growing affluence and economic development with the accompanying increased demands for water have required municipal water authorities to expand treatment and distribution facilities and to search for new sources. In some urban areas that are located on or near the tidewater portions of the Bay, such as Baltimore, Newport News, Norfolk, and Portsmouth, nearby sources of freshwater have long since been developed. Increased competition for new sources at longer distances from the urban centers is thus occurring and the economic, institutional, and engineering problems associated with these large-scale projects are substantial. For example, Norfolk obtains a portion of its present supply from a source located 50 miles from the urban center.

Seasonal variations in flow, and longer-term cyclical trends in climate and hydrology, can cause problems for systems dependent for their supply on surface water. In addition, the periods of highest demand for water often coincide with the lowest river flows, thus complicating the situation further. This is exemplified in Washington, D.C., where supplies are obtained primarily from the Potomac River. The low flow of record, which occurred in 1966, would not be sufficient to meet today's maximum demands.

Degradation of sources is another major problem facing water users in the Chesapeake Bay Region. Surface waters, both reservoirs and free-flowing streams, are especially susceptible to pollution from municipal and industrial waste discharges, agricultural activity, and other upstream sources. Water users that depend on groundwater as a source of supply are also susceptible to contamination. Seepage from septic systems and landfills are notable sources of pollution in groundwater supplies, and saltwater intrusion is another problem affecting some areas around the Bay.

Conflicts also arise in attempts to develop new water supply sources. On-stream reservoirs and pumped storage reservoirs are solutions to requirements for surface water development, but increased competition for land and other economic, social, institutional, technical, and environmental problems must also be considered in the plan-

TABLE 14
INDUSTRIAL WATER WITHDRAWALS, BY SOURCE, MGD
CHESAPEAKE BAY REGION, 1970

Subregion	Public	Self-Supplied				Total	Total Fresh	Percent Fresh
		Ground	Surface	Brackish	Other			
17-1 Baltimore, SMSA	70.0	14.4	2.9	781.2	122.2	990.7	87.3	7.8
17-2 Maryland Eastern Shore	3.0	30.0	1.1	0.7	0.0	34.8	34.1	97.9
17-3 Virginia Eastern Shore	0.3	1.9	0.0	0.1	0.0	2.3	2.2	95.7
17-4 Non-SMSA, Delaware	2.7	14.9	48.0	0.0	0.0	65.6	65.6	100.0
18-1 Washington SMSA	3.3	0.1	1.3	0.0	0.0	4.7	4.7	100.0
18-2 Southern Maryland	0.1	0.7	0.0	0.0	0.0	0.8	0.8	100.0
18-3 Non-SMSA, Virginia	0.2	0.1	27.1	0.0	0.0	27.4	27.4	100.0
21-1 Richmond-Petersburg-Colonial Heights SMSA	22.3	0.3	264.2	0.0	0.0	286.8	286.8	100.0
21-2 Non-SMSA, Virginia	0.2	16.0	0.1	10.3	0.0	26.6	16.3	61.3
22-1 Newport News-Hampton SMSA	4.6	5.0	0.0	90.6	0.0	100.2	9.6	9.6
22-2 Norfolk-Portsmouth SMSA	5.6	3.8	0.0	15.9	0.0	25.3	9.4	37.1
22-3 Non-SMSA, Virginia	0.6	44.9	4.8	0.0	0.0	50.3	50.3	100.0
TOTAL BAY AREA	112.7	132.1	349.5	898.8	122.2	1,615.5	594.5	36.8

ning effort. Also, there is concern at several levels of society regarding proposals for large scale water diversions to serve the major water-short areas. Diversion of water from one watershed to another causes direct reduction of streamflow by the amount withdrawn, and may generate problems in the depleted reaches of the river. The ecological value of a waterway, for example, may be jeopardized by flow reduction, especially during periods of unusually low flows. States rights to river flows and the rights of individuals to flows that are undiminished in terms of quality and quantity (under the Doctrine of Riparian Rights) are other difficulties that complicate any type of large-scale water supply development.

FUTURE MUNICIPAL DEMANDS

The following sections present projections of average daily water use to the year 2020 for central water systems, self-supplied industries, rural domestic populations, livestock and poultry, and irrigation.

Demands for water supplied through central systems has been projected to increase by approximately 170 percent Bay-wide by 2020 (see Table 15). Included in the tabulation are all central public systems, whether large or small, and the sum of demands for all uses, including domestic, industrial, commercial, and public. Projections were based on expected future per capita use rates and estimates of population served. A complete presentation of all demands on public water systems is presented in Appendix 5, along with all assumptions and methodology used to make the projections.

As shown in Table 15, the Baltimore and Washington SMSA's are expected to continue to account for the largest share of the demand for centrally supplied water comprising 75 percent of the total demand in both 2000 and 2020. While the Washington SMSA is expected to experience the largest absolute increase in demand (nearly 800 mgd between 1970 and 2020), the water use in the Southern Maryland area is projected to increase about 700 percent, the largest percentage increase in the Bay Area. Demand is projected to at least double in all of the subregions by the year 2020. Demands in the Bay Area as a whole are expected to increase about 166 percent.

INDUSTRIAL WATER USE

A major consideration in the projection of industrial water supply demands is the impact that Federal water quality goals will have on industrial water use habits. The 1972 Amendments to the Federal Water Pollution Control Act (P.L. 92-500), require application of "best practicable" treatment technology by 1978, and of "best available" technology by 1983 (without further defining the quoted terms). In addition, the Act advocates that a goal of "zero discharge" of pollutants be sought. As industries begin to comply with this directive, and higher levels of waste treatment are achieved, the recycling of wastewater will probably become more economically competitive and consequently more attractive.

Thus, projections of recycling rates for the major water using industries in the Bay Area constituted a major task in the projection process. Recycling rates were derived for three cases which reflect various levels of technology implementation:

a) *advanced technology*—attainment of maximum theoretically possible recycling rates by the year 2000,

b) *constant technology*—maintenance of the rate of recycling at 1970 levels for all industries,

c) *moderate technology*—increase in recycling rates at levels intermediate to either a) or b) above, based on a straight line continuation of projections through 1980.

Industrial water use projections as determined under the assumptions of moderate technology [case (c) above] are shown in Table 16. Figure 14 shows the percent changes that occur over the study period in the gross water demand, intake, consumption, discharge, and recycling rate. Rapidly increasing recycling ratios, which in-

TABLE 15
PROJECTED WATER SUPPLY DEMAND
ON CENTRAL SYSTEMS (MGD)
CHESAPEAKE BAY REGION

		1970	1980	2000	2020	% Increase Over Study Period
17-1	Baltimore, Md. SMSA	268.4	326.1	424.4	561.0	109
17-2	Maryland Eastern Shore	18.6	23.8	35.1	50.2	170
17-3	Virginia Eastern Shore	0.8	1.0	1.5	2.2	175
17-4	Delaware Non-SMSA	1.9	2.8	5.1	8.4	342
18-1	Washington, D.C. SMSA	390.1	497.5	768.2	1,175.4	201
18-2	Southern Maryland	4.2	6.7	18.2	33.7	702
18-3	Virginia Non-SMSA	3.7	5.1	9.1	16.8	354
21-1	Richmond-Petersburg-Colonial Heights SMSA's	79.8	95.2	143.2	222.5	179
21-2	Virginia Non-SMSA	2.8	4.0	6.5	10.4	271
22-1	Newport News-Hampton SMSA	27.8	37.5	51.5	68.5	146
22-2	Norfolk-Portsmouth SMSA	66.9	80.7	111.1	147.3	120
22-3	Virginia Non-SMSA	6.8	10.7	17.1	26.6	291
	TOTAL	871.8	1,091.1	1,591.0	2,323.0	166

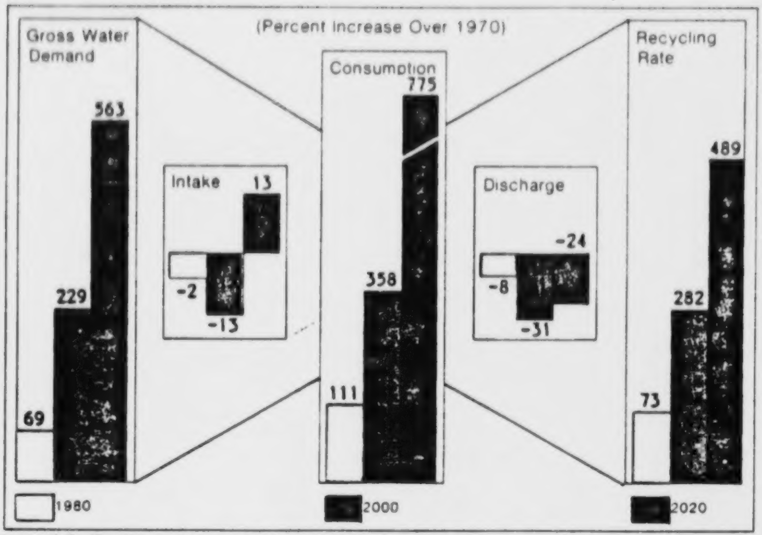

Figure 14: Projected Increase in Manufacturing Water Use, Chesapeake Bay Region

crease from 1.61 in 1970 to 9.48 (a 489 percent increase) by 2020 cause the 13 percent *reduction* in intake by 2000. By the year 2020, however, due to the reduced influence of increases in recirculation rates, intakes show a net 13 percent *increase* over the study period.

Also of interest on Table 16 and Figure 14 are expected trends in industrial water consumption and industrial discharges. Industrial water consumption (water lost from the process or incorporated into end products), for example, is shown to increase approximately 580 mgd, or about 775 percent between 1970 and 2020. This is due to the increase in recycling and the overall increase in manufacturing production. Increased consumption is also at least partially due to the expected increase in evaporative losses accompanying recirculation of water used for cooling purposes. Finally, discharges of industrial wastes are shown to actually decrease by approximately 24 percent over the projection period due to the increases in consumption and recycling rates. A full and complete presentation of the methodology used and the resultant projections of water requirements by industry is provided in Appendix 5.

RURAL DOMESTIC WATER USE

Total rural domestic water use for the Chesapeake Bay Region is presented in Table 17. A moderate increase of about 67 percent (40 mgd) is forecasted over the 50-year study period. The relative insignificance of this figure is evident in comparison with the 1,450 mgd increase in the amount expected to be supplied by central systems.

Increases in water use are expected in all subregions except Southern Maryland and the Newport News – Hampton SMSA. This reflects the facts that total farm population in the Study Area is projected to decline from a 1970 level of approximately 92,800 to 34,800 in 2020 and that future domestic non-farm water use is expected to be dampened somewhat by a conversion of many rural non-farm users to central water systems. Non-farm water use is expected to be by far the largest component of total rural domestic water use in the future accounting for 97 percent of the total by the year 2020.

LIVESTOCK AND POULTRY

As shown in Table 18, future water use for livestock and poultry is expected to decline. The Baltimore SMSA is the only subregion which is expected to experience a significant increase in livestock and poultry use during the projection period. The increases in the Baltimore area are due to significant projected increases in the number of milk cows and water use per animal. Broilers are expected to continue to dominate water use in poultry production on the Eastern Shore with slight increases projected for both numbers of broilers and water use. These increases, however, were not enough to offset the projected 19 percent decrease in livestock and poultry water use in the Bay Region by 2020.

IRRIGATION

As shown in Table 19, the demand for irrigation water is expected to increase dramatically in future years, by about 250 percent between 1980 and 2020. It should be noted that the values shown for 1980, 2000, and 2020 are the volumes of water needed during a dry year, while the figures for 1969 are the *actual* application rates during that year. Slightly over one-half of the irrigation need in 2020 occurs on the Eastern Shore of Maryland.

A major portion of the increase in total irrigation demand in the Study Area over the projection period is due to increases in the corn acreage and the proportion of corn acreage irrigated. This is especially true on the Eastern Shore of Maryland where water used for corn irrigation is expected to account for approximately one-third of the entire Study Area

TABLE 16
PROJECTED INDUSTRIAL WATER USE
CHESAPEAKE BAY REGION, (mgd)

Year	Gross Water Demand	Intake	Consumption	Discharge	Recycling Rate
1970	2,607.9	1,615.5	74.6	1,541.3	1.61
1975	3,512.5	1,823.9	112.5	1,711.4	1.93
1980	4,408.2	1,581.4	157.5	1,423.9	2.79
1990	6,001.6	1,344.1	246.4	1,097.7	4.47
2000	8,591.5	1,397.8	341.3	1,056.5	6.15
2020	17,290.2	1,822.9	652.4	1,170.5	9.48

TABLE 17
PROJECTED RURAL DOMESTIC WATER USE
CHESAPEAKE BAY REGION, mgd

	Subregion	1970	1980	2000	2020	Percent Change During Protection Period
17-1	Baltimore, Md. SMSA	15.6	17.8	15.8	18.4	18
17-2	Maryland Eastern Shore	8.8	11.9	15.9	20.5	133
17-3	Virginia Eastern Shore	1.5	3.0	3.7	4.1	173
17-4	Delaware Non-SMSA	3.6	6.0	7.8	8.8	144
18-1	Washington, D.C. SMSA	10.6	10.1	12.5	13.9	31
18-2	Southern Maryland	4.3	5.8	5.1	3.9	-9
18-3	Virginia Non-SMSA	2.0	3.4	4.0	2.4	20
21-1	Richmond-Petersburg-Colonial Heights SMSA's	4.9	7.9	9.1	9.9	102
21-2	Virginia Non-SMSA	2.9	4.6	5.8	6.5	124
22-1	Newport News-Hampton SMSA	1.2	1.1	0.5	0.6	-50
22-2	Norfolk-Portsmouth SMSA	0.6	3.3	2.9	2.5	317
22-3	Virginia Non-SMSA	3.9	7.7	8.8	8.7	123
	TOTAL CHESAPEAKE BAY REGION	59.9	82.6	91.9	100.2	67

irrigation water demands in 2020. Vegetables. soybeans, tobacco, peanuts, silage, vegetables, and nursery crops are also expected to exert increasing demands for irrigation water in the Bay Region.

SUPPLY ANALYSIS

Results of the region-wide water supply analysis are presented in Table 21. Measures of the available freshwater supply presented in the table are the combination of supply from all sources, including:

- *groundwater* – estimate of ultimate developable yield;
- *surface water* – 7-day, 10-year drought flows at point of departure from subregion; and,
- *impoundments* – safe yield of existing reservoir development.

Significant regional shortages are shown for the Washington, D.C. Metropolitan Area and the three subregions comprising Southeastern, Virginia.

SENSITIVITY ANALYSIS

The foregoing projections of future water supply demands are based on certain assumptions that were required to transform and simplify the many uncertainties of the future. Four areas of critical concern with regard to

TABLE 18
PROJECTED LIVESTOCK AND POULTRY WATER USE
CHESAPEAKE BAY REGION, (mgd)

	Subregion	1969	1980	2000	2020
17-1	Baltimore, Md. SMSA	2.6	2.9	3.2	3.8
17-2	Maryland Eastern Shore	4.2	2.7	2.6	2.6
17-3	Virginia Eastern Shore	0.2	0.1	0.1	0.1
17-4	Delaware Non-SMSA	2.6	1.5	1.3	1.3
18-1	Washington, D.C. SMSA	1.6	1.5	1.1	0.9
18-2	Southern Maryland	0.3	0.2	0.2	0.2
18-3	Virginia Non-SMSA	0.3	0.3	0.4	0.4
21-1	Richmond-Petersburg-Colonial Heights SMSA's	0.8	0.7	0.5	0.4
21-2	Virginia Non-SMSA	0.6	0.6	0.6	0.6
22-1	Newport News-Hampton SMSA	negligible	0.1	0.1	0.2
22-2	Norfolk-Portsmouth SMSA	0.2	0.3	0.2	0.2
22-3	Virginia Non-SMSA	1.2	0.9	1.0	1.3
	TOTAL	14.7	11.8	11.5	11.9

TABLE 19
PROJECTED DRY-YEAR IRRIGATION WATER USE,
CHESAPEAKE BAY REGION*, mgd

	Subregion	1969**	1980	2000	2020
17-1	Baltimore, Md. SMSA	2.9	38.2	42.9	47.9
17-2	Maryland Eastern Shore	32.5	94.0	232.2	722.2
17-3	Virginia Eastern Shore	15.9	66.6	49.6	39.1
17-4	Delaware Non-SMSA	12.2	96.9	111.3	136.8
18-1	Washington, D.C. SMSA	3.1	21.6	72.2	103.1
18-2	Southern Maryland	3.7	14.4	80.6	112.7
18-3	Virginia Non-SMSA	negligible	0.8	1.6	2.1
21-1	Richmond-Petersburg-Colonial Heights SMSA's	1.8	21.6	62.5	70.7
21-2	Virginia Non-SMSA	0.5	13.2	41.6	44.1
22-1	Newport News-Hampton SMSA	0.2	0.3	0.4	0.9
22-2	Norfolk-Portsmouth SMSA	4.4	9.3	8.4	9.1
22-3	Virginia Non-SMSA	2.5	10.5	90.6	68.7
		79.7	387.4	793.9	1,357.4

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* Assuming a 90-day growing season.
** Actual observed use.

water supply were determined to be population growth, recycling in industrial water use, improved irrigation efficiencies, and political decisions which might require increased agricultural production.

One of the major shifts in the demographic profile of the United States in recent years has been the declining birth rate and the resulting decrease in population growth rates. The effect of reduced population levels would most likely be a reduction in the demand in all major water use categories assuming all other factors remain constant.

Future water needs for use in manufacturing may be influenced by even greater improvements in water reuse and recycling than have been anticipated in this report.

A third area of possible impact on water demands includes future climate changes and irrigation efficiencies. Irrigation needs have been projected assuming drought conditions, and under conditions of more normal rainfall, irrigation demands can be expected to be considerably reduced. Projections of irrigation needs also assume that only 65 percent of the water applied is used by the plants, the balance being lost to drainage or evaporation. It is estimated that an increase in irrigation efficiency to 80 percent (a probable maximum) would result in a 19 percent reduction in demand.

A final consideration with regard to future agricultural water demands is the prospect of large scale exports of American agricultural products. If the United States becomes committed to exports of its food products to help alleviate a world shortage, agricultural production may increase in the Bay Area, resulting in greater demands for water.

MEANS TO SATISFY THE NEEDS

There are many potential measures available which could be used in meeting the future water supply needs. Some of the more promising are free flowing streams, impoundments, groundwater, desalinization, and curtailed use of water. These measures are

TABLE 20
PROJECTED WATER SERVICE AREA SUPPLY DEFICITS
CHESAPEAKE BAY REGION

Water Service Area	Deficits in the Existing Source of Water		
	1980	2000	2020
Maryland			
Aberdeen	4.1	10.8	20.6
Annapolis	1.5	2.6	3.2
Baltimore	0.0	0.0	72.0
Bel Air	1.1	2.8	4.4
Cambridge	0.9	1.8	3.2
Centreville	0.0	0.0	0.2
Chestertown	0.3	0.6	1.0
Crisfield	0.5	0.6	0.8
Crofton	0.4	1.2	1.3
Delmar	0.0	0.0	0.0
Denton	0.0	0.1	0.2
Easton	0.3	1.4	3.0
Edgewood (Perryman)	1.2	4.1	9.3
Elkton	0.0	0.0	0.0
Havre de Grace	0.0	0.0	0.0
Joppatowne	0.1	0.2	0.5
King's Heights (Odenton)	1.0	1.7	2.3
Leonardtown	0.0	0.0	0.0
Lexington Park	0.7	3.9	10.0
Maryland City	1.4	2.9	4.8
Pocomoke City	0.0	0.1	0.5
Princess Anne	0.0	0.1	0.4
Salisbury	0.0	0.6	2.0
Severna Park (Severndale)	4.0	5.0	9.3
Snow Hill	0.0	0.2	0.6
Sykesville-Freedom	0.0	0.1	1.0
Westminster	0.1	1.0	1.8
Waldorf	0.6	4.0	10.4
Washington Metropolitan Area			
Washington Suburban Sanitary Commission Washington Aqueduct	0.0	23.0	329.0
Alexandria, Va.	0.0	4.7	11.9
Fairfax County Water Authority	25.5	132.0	308.0
Goose Creek (Fairfax City), Va.	6.8	27.6	63.1
Manassas, Va.	0.0	2.0	3.4
Manassas Park, Va.	0.2	1.8	4.3
Delaware			
Seaford	0.0	0.3	1.3
Virginia			
Ashland	0.0	0.0	0.0
Colonial Heights-Petersburg	0.0	0.0	0.0
Fredericksburg	0.0	0.0	0.0
Hopewell	8.6	15.3	35.6
Mechanicsville	1.0	4.3	11.0
Newport News	4.2	0.0	21.0
Norfolk	1.0	26.4	57.0
Portsmouth (incl. Suffolk)	4.0	15.0	29.2
Richmond	0.0	0.0	0.0
Smithfield	0.0	0.3	0.9
West Point	0.0	0.0	0.0
Williamsburg	3.0	4.7	7.0

more fully discussed in the following paragraphs.

TABLE 21
CHESAPEAKE BAY REGION FRESHWATER SUPPLY ANALYSIS AND PROJECTED DEFICITS, mgd

	Subregion	Freshwater Supply	Future Deficits 1980	2000	2020
17-1	Baltimore, Md. SMSA	1,024*	0	0	0
17-2	Maryland Eastern Shore	865	0	0	0
17-3	Virginia Eastern Shore	250	0	0	0
17-4	Delaware Non-SMSA	290	0	0	0
18-1	Washington, D.C. SMSA	936**	0	62	1,015
18-2	Southern Maryland	234	0	0	0
18-3	Virginia Non-SMSA	119	0	0	0
21-1	Richmond-Petersburg-Colonial Heights SMSA's	678	0	0	110
21-2	Virginia Non-SMSA	170	0	0	0
22-1	Newport News-Hampton SMSA	73***	0	0	12
22-2	Norfolk-Portsmouth SMSA	106	22	62	114
22-3	Virginia Non-SMSA	84	16	179	315

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* Assumes allowable withdrawal from Susquehanna River of 500 mgd.

** Increases to 1,073 mgd beyond 1990 due to Bloomington Project.

*** Increases to 93 mgd beyond 1990 due to Little Creek Project.

NATURAL STREAM FLOW

Rivers such as the Susquehanna, Potomac, Rappahannock, James, and Appomattox presently serve as major sources of water supply for the large urban and industrial areas located along their banks. It is expected that the use of these sources will continue, and indeed, that the withdrawals will be much expanded. The Susquehanna River, in particular, will experience increased demands both upstream and for possible diversion to the Baltimore area. Other interbasin diversions and the use of the upstream portions of the major subestuaries (e.g., the Potomac River) are also alternatives to be considered in meeting future demands.

IMPOUNDMENTS

A major problem in the use of natural stream flows as a source of water supply is the seasonal variation in flow. Peak demands often coincide with the season of lowest flow in the streams. Dam construction is a means by which reduction of variability can be attained, and the dependable flow or safe yield of a watershed increased. Water is stored in the reservoir during periods of excess flow for use during seasonal periods of low flow and high domestic demands. Over the long term, however, average stream flow must exceed demand by a substantial margin in order to maintain a minimum conservation pool, to allow for evaporation, and provide a minimal base-flow below the dam.

GROUNDWATER

Groundwater is another water supply source which can be developed to meet needs in deficit areas. Massive amounts of water are stored in the pore spaces of the soils and rock formations of the Bay Area. However, the amount recoverable is governed by economics, and the geo-hydrologic character of the area. Water withdrawals from wells will cause a lowering of the water table in a three dimensional cone of depression around the well often affecting the yields, capacities, and water quality of other wells in the area. Consequently, groundwater supplies generally serve their most valuable function in areas with small-scale, evenly dispersed demands, such as those for the rural domestic population, agricultural uses, small towns, and industries with relatively low water requirements. Establishments requiring concentrated large-scale water supply developments have invariably located in Western Shore areas where there is a greater potential for development of surface waters.

DESALINIZATION

Conversion of brackish water to freshwater is a technique which can be used in areas which have depleted their conventional sources of supply. Given a supply of sea water or other brackish source, freshwater can be derived by various methods including distillation, membrane, and freezing processes. Because the cost of desalinization is rather high, it is not normally used in water-rich areas such as the Chesapeake Bay Region.

INSTITUTIONAL MEASURES

Institutional arrangements (changes in law, custom, or practice) and policy changes can increase the efficiency of water use, or otherwise effect a dampening of demand. Examples include pricing and metering to encourage thrift, implementation of plumbing codes to encourage water-saving appliances, and restrictions on use during droughts. Homeowners, commercial establishments, and industries alike will curtail usage, to varying degrees, as water supplies increase in cost. Water use restrictions are most effective when they are applied to uses such as lawn watering, car washing, street cleaning, and non-critical commercial and industrial uses in such a way that major inconvenience and/or economic damage is not suffered by the community. Advancing technology and a change in public acceptance could also lead to the reuse of wastewater for municipal purposes in areas depleted of the more traditional sources.

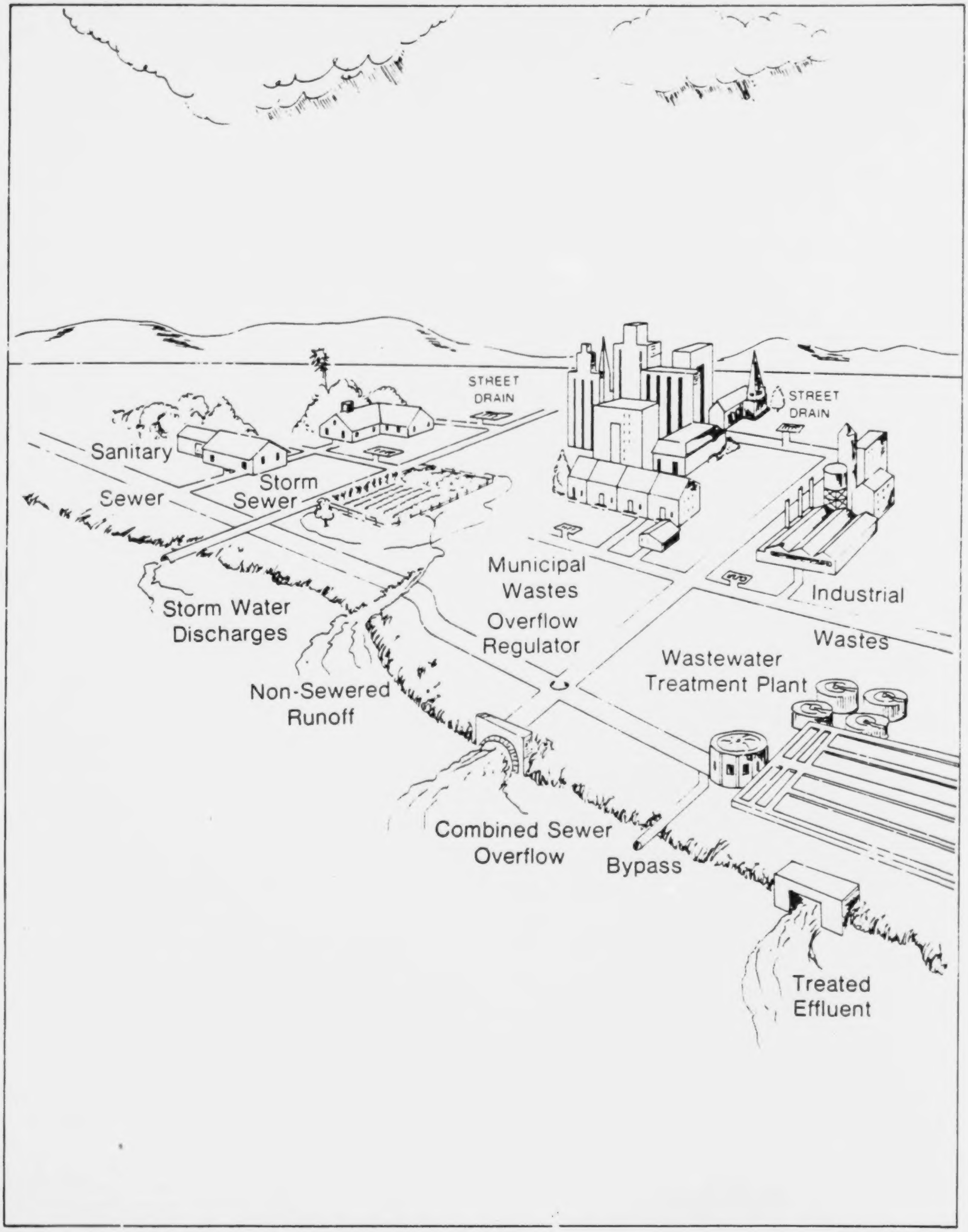
WATER QUALITY

CURRENT STATUS

INTRODUCTION

Water is one of the three basic resources essential for the support of life and without which a Nation, State, or community cannot develop or prosper. Normally, water contains minerals, nutrients, and aquatic organisms which occur naturally. Due to man's activities, however, additional materials are often discharged into the waters. Excesses may cause reductions in the quality of the water resource and render it unfit for intended uses.

Figure 15: Potential Sources of Water Pollution

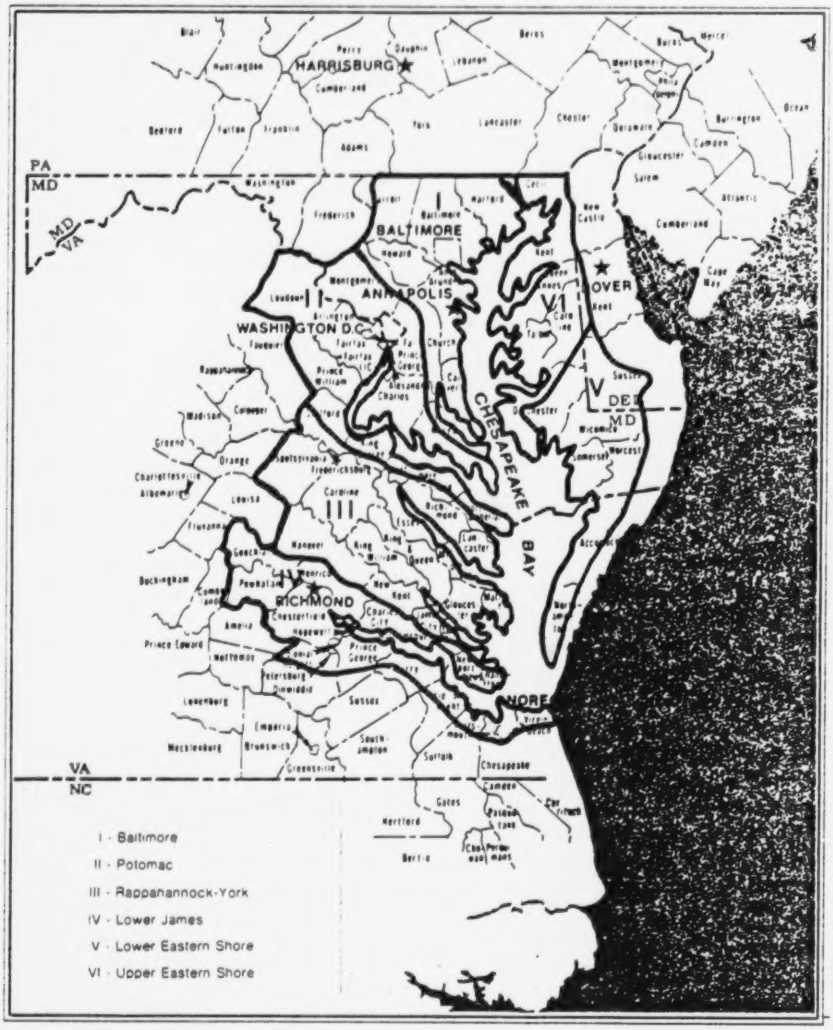


Under such conditions, the water is termed "polluted," that is, it contains harmful or objectionable materials reducing its utility.

Water quality is the term used to describe the biological, chemical, and physical condition of the water in a river, bay, ocean, or underground. What is termed as "good" water quality differs depending on the intended use. Man requires water for drinking that is free of color, pathogenic bacteria, and objectionable taste and odor. Industries which use water primarily for cooling and steam production require water free of materials such as chlorides, iron, and manganese which may be harmful to equipment. Agriculture requires still a different quality of water that is free of degrading materials toxic to plant and animal life. Finally, each form of aquatic life requires water of varying qualities in order to assure its healthy existence.

Water quality problems generally arise when the waste loads imposed by man exceed the water's capacity to assimilate them adequately. The resulting degradation can be very costly, both economically and ecologically. Increased cost of water treatment for municipal and industrial use, the closing of shellfishing areas and the resulting income loss for persons employed by the fishing industry, the loss of valuable recreation areas, the degradation of aesthetic values, the corrosion of structures exposed to water, destruction of fish and wildlife habitats, and the general reduction in the use of receiving waters are all costs of polluted waters.

Figure 16: The Chesapeake Bay Water Quality Study Areas



The sources of water pollution may be classified as either "point" or "non-point" and are illustrated in Figure 15. Point sources are those in which the degrading material is discharged from a specific point. Non-point sources are those in which the degrading material reaches the water course through flows over a large area.

The major point sources of water pollution are:

1. Municipal sewage outfalls.
2. Industrial waste outfalls.
3. Combined sewer outfalls.

The major non-point sources of water pollution are:

1. Agricultural runoff.
2. Urban runoff.
3. Marine transportation spills.

This section of the report presents the findings of the Cheaspeake Bay Study as they relate to the quality of the waters of Chesapeake Bay and its tributaries. It is essentially a continuation of the 1970 inventory of water quality presented in the *Existing Conditions Report.* With the passage of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) much of the water quality work originally envisioned as part of the Chesapeake Bay Study has been accomplished at the State and local level.

The geographical area considered for the water quality study is based on the river basins in the Chesapeake Bay's drainage area. Within the Chesapeake Bay Region, 18 separate river basin segments as designated by the States of Maryland, Virginia, and Delaware were combined to form six regional study areas. These are shown in Figure 16, and a complete listing of the major river basins within each study area is presented in Table 22.

WATER QUALITY PARAMETERS

The parameters used to measure water quality are of three major types: physical, chemical, and biological. The most important of these parameters

TABLE 22
CHESAPEAKE BAY WATER QUALITY STUDY AREAS

Study Area I – Baltimore

- Lower Susquehanna River
- Bush River
- Gunpowder River
- Patapsco-Back River
- Patuxent River
- Magothy River
- Severn River
- South River

Study Area II – Potomac

- Potomac River
- Occoquan River
- Anacostia River

Study Area III – Rappahannock-York

- Rappahannock River
- York River
- Pamunkey River
- Mattaponi River
- Ingram Bay
- Fleets Bay
- Mobjack Bay

Study Area IV – Lower James

- James River
- Appomattox River
- Back River
- Elizabeth River
- Lynnhaven Bay

Study Area V – Lower Eastern Shore

- Pocomoke River
- Manokin River
- Wicomico River
- Nanticoke River

Study Area VI – Upper Eastern Shore

- Choptank River
- Wye River
- Chester River
- Eastern Bay
- Northeast River
- Elk River
- C & D Canal

The major source of information for this analysis was the State Water Quality Management Plans required by section 303(e) of P.L. 92-500, which provided projections of wastewater loadings and water quality needs for each river basin. "Problem area" information was taken from the State Water Quality Inventories prepared under Section 305(b) of P.L. 92-500. are Biochemical Oxygen Demand (BOD), bacteriological indicators, suspended solids, dissolved solids, temperature, dissolved oxygen, nutrients, chlorophyll *a*, pH, and heavy metals. By monitoring and studying these water quality parameters, standards have been and are being developed to control water pollution. These standards, required of each state by P.L. 92-500, reflect the goal of water quality management for the present and future. A more detailed description of these and other important parameters is presented in Appendix 7, "Water Quality," and in the Glossary of this Summary.

EXISTING WATER QUALITY CONDITIONS

Characterizing the quality of the Bay's waters in one word is difficult because of the wide variety of conditions encountered in an area of this size; however, a blanket statement would probably conclude that the water quality of the Bay itself is good, with most of the severe problems occurring in the tributaries especially near areas of high population concentrations. However, increasing loads from municipal sewage treatment plants and industrial sources, as well as from agricultural and storm runoff, and marine transportation spills are causing stresses and problems, some very severe, throughout the Bay Region. In addition, as yet unidentified pollutants may be present in the Bay and its tributaries causing environmental damage. For example, preliminary results from a study by the Smithsonian Institution indicate a possible link between two widely used agricultural herbicides and the decline of certain aquatic grasses in Chesapeake Bay during the last decade.

Figure 17 summarizes the major water quality problems of the larger tributaries and their surrounding land areas. In general, municipal and industrial wastes have been found to be the major problems in the populated areas of Baltimore, Washington, Richmond, and Norfolk. Other less populated areas suffer mainly from agricultural and land runoff as well as smaller amounts of municipal discharges. The following sections present a capsulated summary of the existing water quality conditions as they relate to the established water quality standards for each of the six major water quality study areas in the entire Bay Region. More detailed information on water quality and the standards for these basins is presented in Appendix 7, "Water Quality."

a. *Study Area I - Baltimore.* Nutrients appear to be the major problem in the Lower Susquehanna River Basin as algal blooms have been on the increase over the past several years. Heavy municipal and industrial loads upstream have been identified as the major contributors. High nutrient concentrations have also been identified in other major rivers in the Baltimore Study Area including the Patuxent, Severn, South, Gunpowder, Bush, and Back Rivers.

In the Patapsco River, and especially the Baltimore Harbor Area, 32 major industrial dischargers and 10 major municipal dischargers along with the heavily urbanized development in the area are creating stressed conditions in the surrounding waters. Major problems include low dissolved oxygen contents, high bacterial concentrations, and undesirable levels of other pollutants such as heavy metals and oil.

The Patuxent River also suffers from the heavy development along its river banks. Eighteen major municipal facilities, increased construction and urban runoff, and faulty septic systems have been named as the principal contributors to the occasional low dissolved oxygen contents, turbid waters, and increased levels of nitrogen and phosphorus found in the waters. Bacterial concentrations have also caused problems in the area, especially during periods of low flow.

b. *Study Area II – Potomac.* Serving as the major water supply for the District of Columbia and surrounding areas, the Potomac River is stressed by the heavy urban development along its river banks in the Washington Area. Agricultural runoff from upstream sources contributes high volumes of nutrients and bacterial contamination prior to entering the metropolitan area.

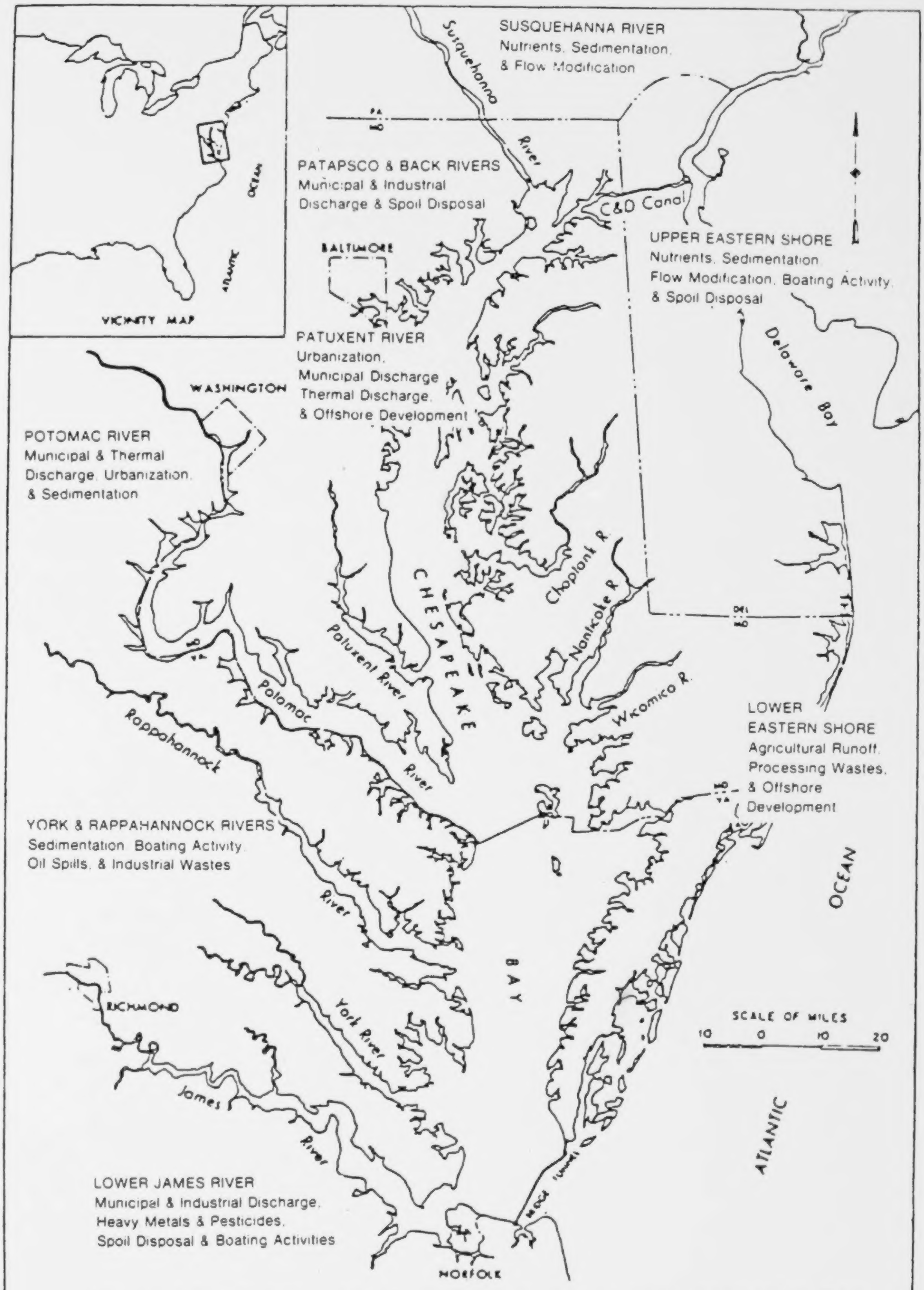

SUSQUEHANNA RIVER
Nutrients, Sedimentation, & Flow Modification
Susquehanna River
PA
MD
PATAPSCO & BACK RIVERS
Municipal & Industrial Discharge & Spoil Disposal
C&D Canal
BALTIMORE
UPPER EASTERN SHORE
Nutrients, Sedimentation, Flow Modification, Boating Activity, & Spoil Disposal
VICINITY MAP
OCEAN
ATLANTIC
PATUXENT RIVER
Urbanization, Municipal Discharge, Thermal Discharge, & Offshore Development
Delaware Bay
WASHINGTON
POTOMAC RIVER
Municipal & Thermal Discharge, Urbanization, & Sedimentation
CHESAPEAKE
Choptank R.
Nanticoke R.
MD
VA
Patuxent River
Potomac River
Wicomico R.
Rappahannock
LOWER EASTERN SHORE
Agricultural Runoff, Processing Wastes, & Offshore Development
YORK & RAPPAHANNOCK RIVERS
Sedimentation, Boating Activity, Oil Spills, & Industrial Wastes
River
OCEAN
BAY
RICHMOND
SCALE OF MILES
10 0 10 20
York River
James River
ATLANTIC
LOWER JAMES RIVER
Municipal & Industrial Discharge, Heavy Metals & Pesticides, Spoil Disposal & Boating Activities
NORFOLK

Figure 17: Existing Water Quality Problems in Chesapeake Bay

Near the District, high volumes of municipal wastewater (led by the 309 mgd from the Blue Plains Plant) and urban runoff cause some dissolved oxygen depletions while adding to the nutrient enrichment of the river. Improving as it nears Chesapeake Bay, the Lower Potomac River generally meets standards but still suffers from the development upstream and especially the sediment generated from urban and agricultural runoff. In 1973, over 3 million tons of sediment were emptied into the Potomac Estuary and primary production, while not heavily stressed, appears to have suffered.

Tributaries such as the Anacostia River, Piscataway Creek, Rock Creek, Occoquan River, Goose Creek, and Port Tobacco River also suffer from urban and agricultural runoff as well as discharges from the sewage treatment plants in the area. The main problems are high bacterial concentrations, occasional dissolved oxygen depletions, turbid waters, and increasing nutrient concentrations.

c. *Study Area III – Rappahannock-York.* The Rappahannock River Basin, extensively rural in nature, has relatively minor water quality problems with the exception of the waters near the City of Fredericksburg. High bacterial concentrations and occasional dissolved oxygen sags in the mainstream have been traced to extensive agricultural runoff throughout the entire basin and some of the smaller sewage treatment plants in the area which discharge partially treated wastes. The Great Wicomico River and Indian, Cockrell, and Dymer Creeks also experience high bacterial concentrations and occasional dissolved oxygen sags for much the same reasons. Boating activity near the Windmill Point area is causing some concern as bacterial concentrations, nutrients, and dissolved oxygen depletions have been on the increase.

The York River, near its headwaters, exhibits water of excellent quality. In the West Point Area, however, degradations in the form of low dissolved oxygen, low pH, and high bacterial concentrations occur, mostly the result of urban runoff, landfill runoff, swamp drainage, and discharges from the nearby sewage treatment plant. Sedimentation is also a growing problem throughout the entire basin with the primary contributor being urban runoff, although only 2 percent of land area is in urban use.

King, Carter, and Sarah Creeks, all tributaries to the York River, have high bacterial and nutrient concentrations which are attributed to local STP discharges and marina activities in the surrounding areas. Near the mouth of the York River, dissolved oxygen depletions have created some problems and are caused by the "tidal prism" effect which prohibits the mixing of the layers of water that replenish oxygen supplies.

d. *Study Area IV – Lower James.* The Lower James River (from the City of Richmond to Chesapeake Bay) ranks as one of the most heavily developed and industrialized basins in the Bay Region with 35 major sewage treatment plants and 29 large industrial firms in its drainage area. Most of the water quality problems found in the basin are direct results of the intensive development in the Richmond, Hopewell, and Norfolk-Newport News Area. Major problems in the basin include low dissolved oxygen, high nutrient concentrations, high bacterial concentrations, high chlorine toxicities, and excessive amounts of heavy metals. Tributaries such as the Elizabeth and Lynnhaven Rivers, and Bailey and Ashton Creeks, are also degraded and have the same problems and sources as the mainstem of the James. Shipping in the Hampton Roads complex has created some problems, with occasionally high bacterial concentrations and oil spills being the most prevalent. Pesticide concentrations, while not frequently monitored in the past, have also become an area of great concern in the James Basin following the "kepone" incident of 1976. Illustrative of the magnitude of the concern was the closure, for a 7-month period, of the lower James River to all fishing, by Virginia Governor Mills Godwin in June of 1976.

e. *Study Area V – Lower Eastern Shore.* The Pocomoke River, while generally of good quality, has shown some degradation near the Pocomoke City, Snow Hill and Crisfield Areas. Low dissolved oxygen, high bacterial concentrations, and nutrient enrichment are the main problems. Improvement of water quality conditions, however, has been realized in recent months due to improved treatment at sewage treatment plants in the area. The main sources of degradation in the basin are now considered to be septic tank leakage and the poor flushing action of the Estuary particularly during low flow conditions. The Nanticoke and Wicomico Rivers, especially in the Salisbury area, suffer from high bacterial concentrations. Shellfish closures in the area are necessary because of the high volumes of storm runoff, septic tank leakage, and the low level of treatment provided by the existing sewage treatment plants. Agricultural runoff is also a problem in the basins, contributing bacteria and nutrients from soils, manure seepage, and feedlot runoff.

f. *Study Area VI – Upper Eastern Shore.* The Choptank, Chester and Elk Rivers are all basically rural in character and suffer from agricultural runoff and septic system leakage problems. High nutrient concentrations near the upper Bay have brought about increasing algal blooms in the Chester and Elk Rivers. Small sewage treatment plant discharges and scattered seafood packaging wastes have caused some bacterial problems near the more populated areas of the Chester and Choptank Rivers. Finally, pleasure boating activities in the summer and fall seasons are causing some bacterial problems near the mouths of all the major rivers in this area.

FUTURE WATER QUALITY NEEDS

MUNICIPAL WASTEWATER

Increasing levels of population and per capita income in the Chesapeake Bay Region will mean increased municipal wastewater volumes. Table 23 presents data by river basin on anticipated municipal wastewater flows and treatment needs.

As shown in Table 23, projected wastewater flows exceed the 1975 treatment plant capacity in all of the river basins for which projections were available. In addition to the need for more capacity, treatment plants providing more advanced treatment of the wastewaters will be required in most areas of the Bay Region in order to meet the requirements of PL-92-500.

TABLE 23
FUTURE MUNICIPAL WASTEWATER TREATMENT NEEDS, SELECTED AREAS

River Basin	Projected Flow Year	Projected Flow (mgd)	Existing Capacity (mgd, 1975)	Deficit (mgd)
Lower Susquehanna	1995	3.27	1.87	1.40
Patapsco	1990	261.60	238.76	22.84
West Chesapeake	2000	32.80	19.40	13.40
Patuxent	2000	96.30	39.40	56.90
Washington Metro.	2000	543.80	344.64	199.16
Northern Virginia	2020	363.30	111.98	251.32
Rappahannock	2020	19.54[1]	8.38	11.16
York	2020	39.60[1]	2.98	36.62
James (Lower)	2020	386.00	163.97	222.03
Accomack-Northampton	2000	1.26	0.74	0.52
Pocomoke	2000	3.00	2.65	0.35
Nanticoke	1995	13.56	12.80	0.76
Elk	1995	4.99	3.40	1.59

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[1] Based on total population and not population served.

INDUSTRIAL WASTEWATER

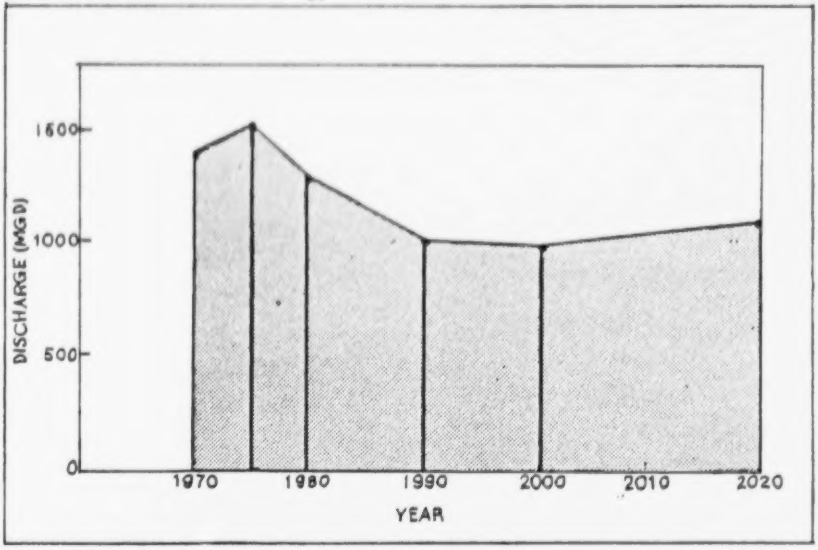
Industrial discharges will have a great bearing on the achievement of water quality management goals in the future, especially in highly industrialized areas such as Baltimore, Richmond-Hopewell, and Norfolk. Industrial discharges are a function of industrial water supply and consumption, the level of industrial development, and most importantly, the amount of water recycled. These parameters are discussed in detail in Appendix 5, "Municipal and Industrial Water Supply."

The industrial discharge projections presented in Figure 18 are median range values which balance projections reflecting simple historical data on one hand and maximum attainable recycling technology on the other. The curve presented in Figure 18 acknowledges that, while recycling rates will indeed continue to improve, it is more likely that a lesser degree of implementation of technology in industrial water reuse will occur. Although the discharge projections do not specifically address actual concentrations of waste products or projected discharge loadings, they do, however, serve as an indicator of the marked decrease in industrial discharges that may be expected in pursuit of National water quality goals. It should be noted that the values presented in Figure 18 include only the five major water-using industrial groups in the Chesapeake Bay Region (i.e., chemicals, primary metals, paper and allied products, food and kindred products, and petroleum). These industries, however, account for about 82 percent of the total water withdrawals in the Bay Region.

OTHER POINT AND NONPOINT SOURCE PROBLEM AREAS

a. *Thermal Discharges:* Increases in the demand for electric power, as outlined in Appendix 13, Electric Power, will create the additional problem of the disposal of heated cooling waters. In 1972, an average of nearly 7,700 mgd was discharged from power plants into Chesapeake Bay waters, almost 8.5 times the average discharge of sewage treatment plants in the Area. Projected withdrawals for 1980 are expected to be near 8,500 mgd; of which 3,500 are required for the Surry and Calvert Cliffs nuclear power plants alone. A major concern is the effect such heavy concentrations of heated waters will have on the aquatic environment. Complicating the problem are the physical characteristics of Chesapeake Bay, an estuary which is relatively shallow and of moderate temperature, thereby limiting its efficiency for the dispersion of heated effluents.

Figure 18: Industrial Discharge Projections for the Chesapeake Bay Region with Moderate Technology



b. *Chlorine:* Chlorine, used widely as a fouling preventative in industry and as a disinfectant for municipal wastes, has in combination with elements in receiving waters been found to cause up to 90 percent reduction in primary productivity near wastewater treatment plant discharges. Future threats center around an overabundance of total chlorine residuals, due to the increased volumes of both municipal and industrial discharges as well as the required lowering of coliform densities in discharges which require increasing amounts of disinfectant.

c. *Agricultural and Urban Runoff:* With approximately 40 percent of the Bay's land area in agricultural use, pollutants such as nutrients, pesticides, sediment, and animal waste products can be expected to continue to contribute a significant loading. Although the percentage of land in agricultural use is projected to decrease, intensive farming practices which attempt to grow the same or greater amounts of crops on smaller land areas may contribute even greater loadings than before. Urban runoff may be expected to increase markedly as population growth and urban expansion continue. Large amounts of runoff containing oils, chemicals, and sediments cause significant problems near the major cities of the Bay Region.

d. *Oil and Marine Transportation Spills:* With the projected increase in both total traffic and the total amount of oil products shipped on Chesapeake Bay (see Appendix 9, Navigation) the probability of accidental spills may also increase. Other hazardous chemicals in transport will also be subject to accidental spills as Bay traffic increases. Other sources of oil, especially municipal discharges, have not yet been thoroughly researched. More detailed information on these subjects can be found in Appendix 15, Biota.

e. *Sedimentation:* Sedimentation, a natural phenomenon the level of which has been increased beyond natural levels due to man's activities, can also be expected to increase in the future as population grows in the Bay Region. A projected doubling of population in the Chesapeake Bay Region between 1970 and 2020 means that the existing number of residences, office buildings, etc., will also roughly have to double, implying a tremendous amount of construction activity with its potential for causing sedimentation problems during the projection period.

f. *Recreational and Commercial Boating Activities:* The large and increasing numbers of both commercial and recreational vessels currently contribute a significant amount of raw sewage through direct overboard discharges. The problems caused by these discharges are expected to continue into the future until adequate pumping facilities can be installed to treat the sewage at marina and port facilities.

g. *Septic Tank Failures:* Failing septic systems, which cause major problems in many of the rural areas of the Chesapeake Bay Region can be expected to continue to plague those areas until either the old systems are repaired or sewer service can be provided. In those areas outside expected sewerage expansions and where poor soil conditions exist, new methods of handling wastes from individual homesites will have to be found before improvement can be expected.

h. *Solid Waste Leachates:* Seepage from the ever increasing number of solid waste dumps and sanitary landfill sites may also pose a serious threat to water quality in the future, especially in the contamination of groundwater supplies. Protection of both private and public water supplies by sealing them off from the potentially high amounts of sodium, potassium, calcium, magnesium, and organic pollutants characteristic of this leachate will be necessary to avoid contamination problems in the future. Also, some means of treating the collected leachate will be necessary.

MANAGEMENT AND OTHER PROBLEM AREAS

In pursuing the goals of improved water quality, numerous problems are being encountered by the responsible management agencies. Some common management-related problems are presented below:

a. *Financial Capabilities:* The adequacy of existing technology to meet goals and objectives of P.L. 92-500 does not appear to be a significant problem. The costs associated with implementing these improvements, however, appears to be a problem of great magnitude. In a 1973 report by the *National Water Commission* to the President of the United States, it was estimated that implementation of pollution abatement policy based on "Best Available" technology for treatment of both municipal and industrial point source wastes by 1983 would require expenditures of about $460 billion through 1983. Implementation of a true "no discharge" policy had been estimated to cost several times that amount.

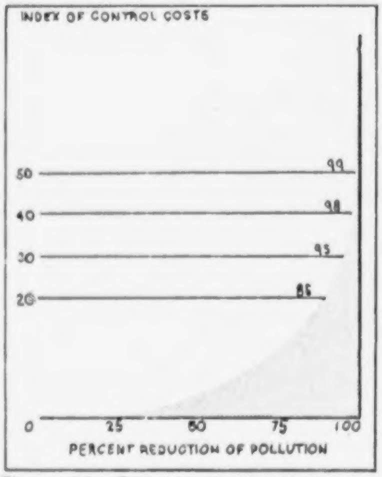


Figure 19: Pollution Control Costs as a Function of Control Levels

Figure 19 illustrates how costs increase as levels of treatment increase. As indicated, a clean-up of the last 1 percent of pollution involves a doubling of the already large costs involved in eliminating the first 99 percent.

b. *Manpower:* The need for well-trained personnel to operate wastewater treatment plants is important, as the ability of a treatment facility to achieve design efficiency is primarily dependent upon the skill and knowledge of the operator. The expected expansion and increased complexity of wastewater treatment plants in the future will require an increasing number of technically competent and adequately trained personnel.

c. *Lack of Data Base:* Basic data on water quality and the effects of changes in critical water quality parameters on the environment, provides a basis for planning, decision making, and evaluation. An existing and projected need is for expanded monitoring of trends in water quality to improve selection of effective management measures and for enforcement purposes. Equally important is the critical need for assurance that all potential users know what type of data is available so that they can obtain it when needed.

MEANS TO SATISFY THE NEEDS

This section includes a description of those measures that can be employed to meet present and future water quality needs. The measures are discussed in terms of physical alternatives and management or legislative actions.

PHYSICAL ALTERNATIVES

There are two basic approaches to physically controlling or treating the increasing volume of wastewater flows. One of them involves the installation of water-saving devices and methods that cut down or limit the volume of wastewater generated. The other approach concerns the various methods and equipment available for treatment and disposal of waste products after generation.

a. *Improving Water Use Technology:* This means is actually a method which limits the production or per capita consumption of water and ultimately wastewater flow. It usually involves a "fine-tuning" of plumbing devices which will use less water to do the same job. Among the plumbing provisions are toilets which use less water, pressure relief valves which limit water pressures, customer education programs which encourage the wise use of water, and shower heads which limit flows. The institution of these measures has been difficult because of the lack of appropriate plumbing parts, additional costs for refitting older devices, and follow-up adjustments. Plumbing code revisions seem to hold the most hope in the future for instituting these measures.

b. *Increased Industrial Treatment and Recirculation:* In keeping with the requirements of present legislation, improvement in treatment technology (percent pollutant removal) will most likely result in water of better quality. This in turn will result in an increased ability of industrial plants to reuse this water in the production process and decrease volumes of flow to the rivers.

Two specific alternatives are pretreatment and by-product recovery. Pretreatment of industrial wastes removes the unique pollutants of an industrial process prior to discharge in municipal sewers. The potential use or sale of waste by-products of the industrial process will also create incentives for industry to re-circulate wastes and remove these pollutants as opposed to dumping them in watercourses. In the pulp and paper industries for example, certain wastes can be synthesized to produce artificial vanilla flavoring and other valuable by-products.

c. *Increased Municipal Treatment:* Increasing both the capacity and pollutant removal capabilities of Bay area sewage treatment plants can contribute greatly to the improvement of the surface waters of Chesapeake Bay. Emphasis can also be placed upon the construction and enlargement of regional sewage treatment plants which have shown the ability to treat wastes more effectively as well as more economically. Larger facilities also relieve overloading due to combined sewers and enable presently unserved areas to receive wastewater treatment.

d. *Cooling of Thermal Wastes:* Three methods of cooling the heated waters of power plants are currently available; wet towers, dry towers, and cooling ponds. In wet towers, the hot effluent is exposed to air circulating through a specially shaped tower. As water evaporates, heat is lost. Dry towers pass the effluent through a series of pipes over which cool air is passed and heat is lost by radiation. Cooling ponds are also a possible solution, but require larger areas than the other alternatives. Appendix 13, "Electric Power," presents more detailed information on alternatives available to reduce the problems associated with thermal discharges.

e. *Land Treatment of Wastewater:* In a land treatment operation, secondarily treated wastes are transported to the land treatment site instead of being disposed of in the watercourses. The effluent is then stored, chlorinated, and applied to the land surface by a variety of basic means. The underlying concept is based upon the use of the soil mantle and its vegetative cover which acts as a "living filter" to remove pollutants. By this process the oxygen demanding substances are destroyed by oxidation, the nitrogen and phosphorous consumed by plant growth, and the purified water returned to the ecosystem by groundwater recharge. Heavy metals are also immobilized by adsorption on soil particles.

f. *Control of Non-Point Source Pollutants:* Actions which seek to reduce the amount of non-point source pollutants such as sediment, pesticides, oils, heavy metals, and coliform organisms are also very important in improving water quality in the Bay and its tributaries. Agricultural runoff policies which have proven most effective are contour plowing, ridge planting, the construction of sedimentation ponds and terraces, and the diversion and treatment of wastes from livestock feed yards. Urban runoff controls consist mainly of developing policies to implement separate storm drains and installation of retention basins which store runoff for later treatment or disposal.

g. *Other Physical Methods:* Techniques such as deep well injection of wastes, runoff controls, alternative means of wastewater disinfection, and methods for improving assimilative capacities of waterways are some other methods that have been proposed as at least partial solutions to the increasingly complex problems of waste disposal in the Chesapeake Bay Region. These alternatives are discussed in detail in Appendix 7.

MANAGEMENT AND LEGISLATIVE ACTIONS

a. *Management Actions:* The major management options available to reduce, re-distribute, or limit the demand for water and thereby the volume of municipal wastewaters, are pricing policies, sewer moratoriums, and consumer education. Pricing policies seek to reduce consumption of water by levying higher rates during those periods of time when the demand is high. Sewer moratoriums have been used in areas where demands for water and sewerage service have exceeded the ability to provide adequate treatment. These moratoriums usually prohibit the extension of old systems. This method of redistributing demand has been used effectively in the Washington Metropolitan area where counties in the surrounding metropolis have implemented moratoriums as emergency measures. Consumer education practices stress the voluntary conservation of water. The basic elements of a program of this type might involve the distribution of information on the water consumption characteristics of major appliances of all brands. Other programs might include door-to-door distribution of water saving packages containing instructions for correcting leaky and excessive water-using appliances as well as dye tablets to help detect leaks within the home.

b. *Legislative Actions:* For the present and near future, the requirements of the Federal Water Pollution Control Act Amendments of 1972 appear to serve as a schedule to implement the desired water quality goals for both the Chesapeake Bay Region and the United States. Appendix 7 provides a summary of the major provisions of PL 92-500 and other recent supplemental legislation.

OUTDOOR RECREATION

CURRENT STATUS

EXISTING SUPPLY AND DEMAND

The Chesapeake Bay Region's approximately 7,300 miles of shoreline and 4,400 square miles of water surface area along with its temperate climate make it a very attractive place for water-related recreation activities such as sailing, boating, swimming, picnicking, and camping. In order to better plan for the use of the resource, Statewide Comprehensive Outdoor Recreation Plans (SCORP's) were prepared by all the States in the Study Area under the provisions of the Land and Water Conservation Fund Act of 1965. These studies included an inventory of existing boating, sailing, swimming, camping, and picnicking activities. The results of these surveys show that the Study Area had a public supply at the time of the survey of approximately 440 boat ramps, 20,200 camping sites, 26,600 picnic tables, and 2,500 acres of beach and swimming pools.

In many cases, the provision of facilities for public recreation have not kept pace with the burgeoning demand. In the Bay Region, the number of boat ramps and picnic tables are not sufficient to meet existing public demand. It is estimated that an additional 130 boat ramps and 13,600 picnic tables are needed. On the other hand, there is presently a surplus of swimming and camping facilities in the Bay Region.

Due to the nature of outdoor recreation in the Chesapeake Bay Region, boating and sailing activities deserve special attention. Only about one-half of one percent of the water surface area of Chesapeake Bay and its tributaries would be required to meet current boating and sailing demands. The inability to satisfactorily meet current boating and sailing demands, however, is not due to an absence of water surface area, but as indicated above, to an insufficient supply of public slips and launching ramps. This is further illustrated by the fact that the 28,000 trailer boats registered in Maryland in 1971 had access to the Bay through only 125 public boat ramps.

Figure 20 below presents the 1970 resident (those living in the Bay Region) outdoor recreation needs and surpluses by recreation subregion. The boundaries of these subregions conform to those of the State planning regions as defined in the SCORP's. Together these subregions make up the primary areas of recreation demand within the Chesapeake Bay Region.

As shown in Figure 20, the deficiency in boating ramps is most acute in the Baltimore and Washington Metropolitan Areas while the surpluses are the greatest in the much more sparsely populated areas of the Eastern Shore of Maryland and Tidewater Virginia. Because of this, boat owners in the Baltimore and Washington areas must often travel unusually long distances to launch their vessels in relatively uncrowded environs.

The large 2,100 acre surplus of swimming pool and beach acreage is due primarily to wide expanses of ocean beach on the Maryland, Virginia, and Delaware coasts. It is significant to note that the most highly urbanized regions, Baltimore, Washington, and Richmond show the greatest need for additional swimming space.

More subregions have a deficiency of picnic tables than of any other outdoor recreation facility. Only the Southern Maryland, Virginia Tidewater, and the Eastern Shore of Virginia subregions have a surplus of picnic tables. Typically, the greatest shortages are in the metropolitan areas of Baltimore and Washington which combined account for approximately 67 percent of the Bay Area's total net resident need. The Richmond and Hampton Roads subregions also have large picnic table needs.

The Baltimore SMSA and Maryland portion of the Washington SMSA subregions are the only areas which presently lack an adequate number of camping sites to meet resident needs. Combined, these two subregions show a need for 2,100 camp sites. The remainder of the Bay Region has a present surplus of 15,500 sites, which means the entire Bay Region has a total surplus of 13,400 sites.

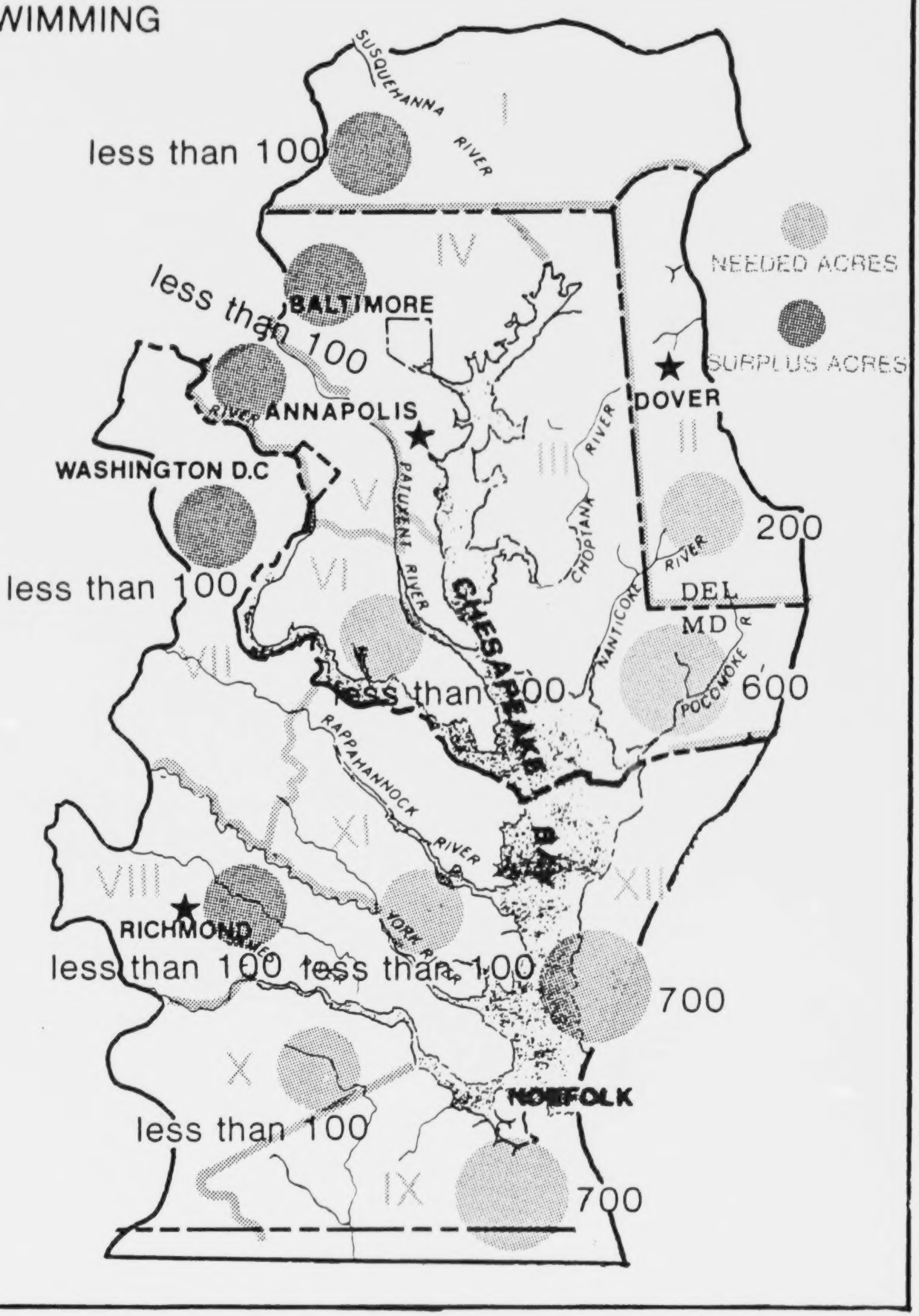
It is important to note that the outdoor recreation needs and surpluses presented in Figure 20 are resident demands only. Non-resident demand was not disaggregated by subregion-of-occurrence due to time and data constraints. If non-resident demand is taken into account, however, there is a substantial increase in the need for boating and sailing ramps, swimming acreage, picnic tables and camping sites.

PROBLEMS AND CONFLICTS

From the standpoint of the general public, Chesapeake Bay is one of the most inaccessible estuaries in the Nation. Private interests have responded to the deficits in public recreational facilities by providing facilities of their own. As a result, an estimated 47 percent of all land and water recreation areas in the Bay Region are in private control. Control of Chesapeake Bay's shoreline by private interests is even more extensive. For example, according to a study conducted by the Chesapeake Bay Interagency Planning Committee, only three percent of the Maryland shoreline is publicly-owned.

Much of the recreationally desirable land available is in competition with other forms of land development such as private homes, utility development, or military reservations. For example, in urban areas where recreation opportunities are most urgently needed, the shoreline has often been developed as major port and industrial complexes. A significant percent of the publicly-owned shoreline is held by the Federal government, primarily the military, and is unavailable for use by the general public.

SWIMMING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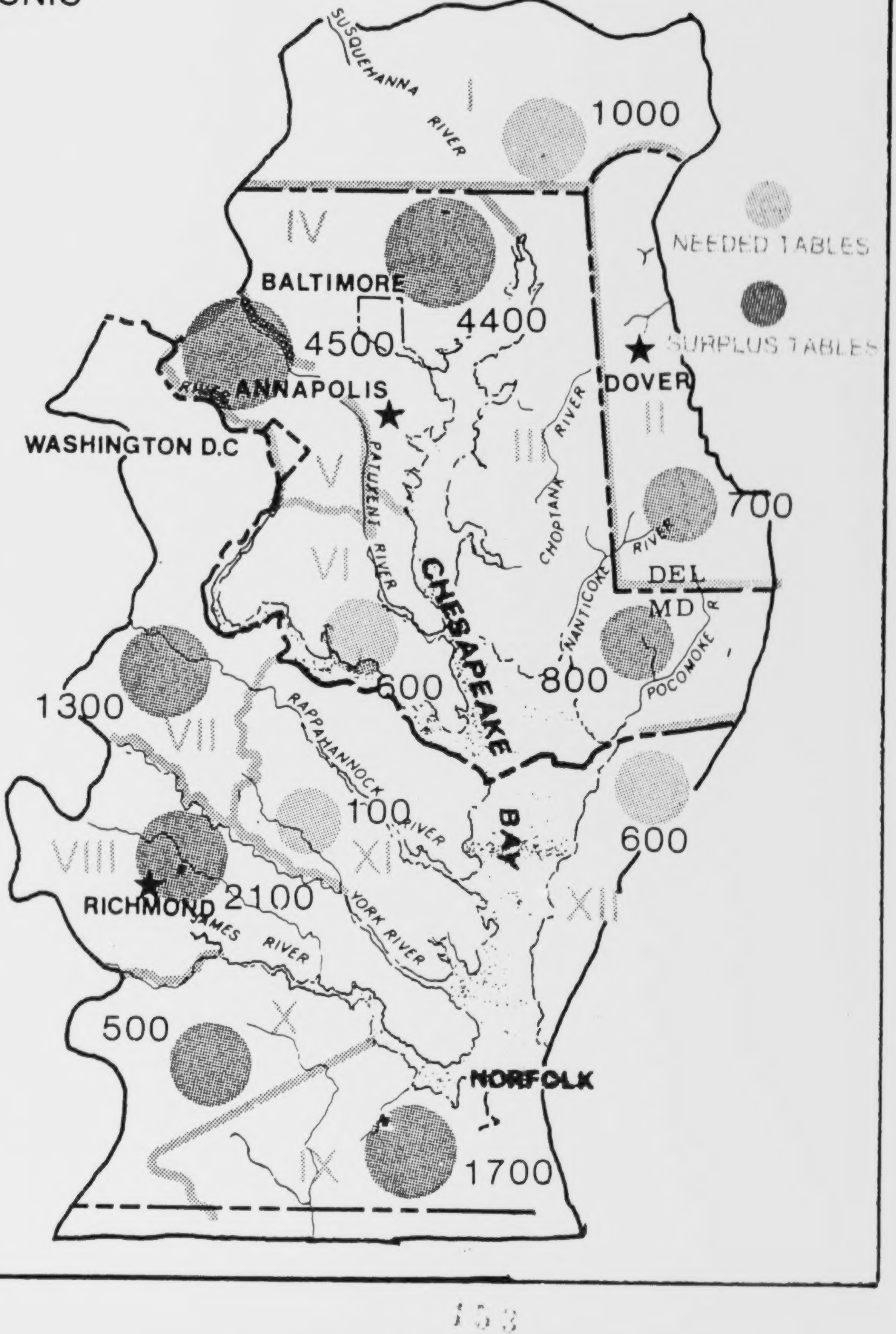
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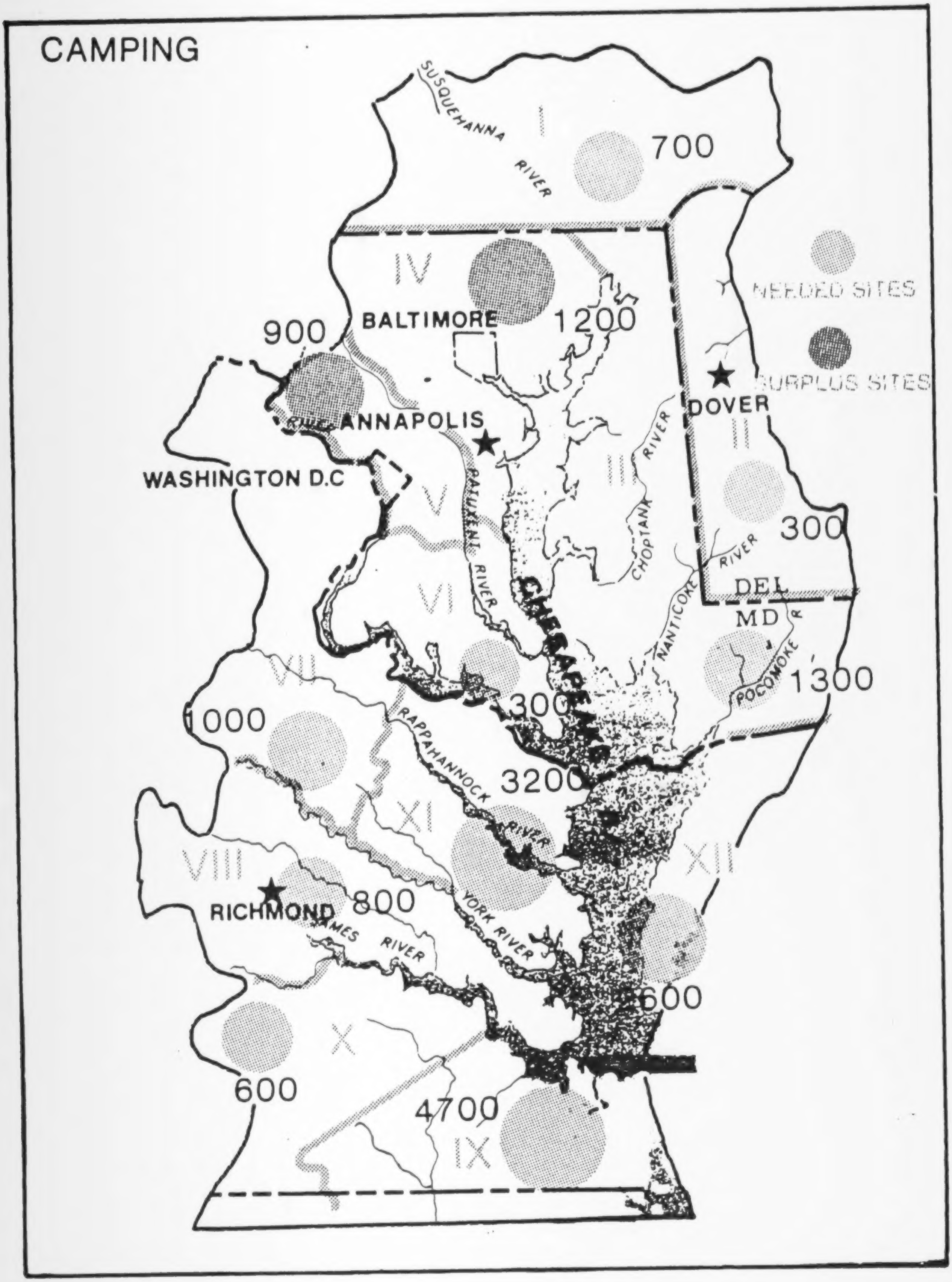
SURPLUS TABLES

CAMPING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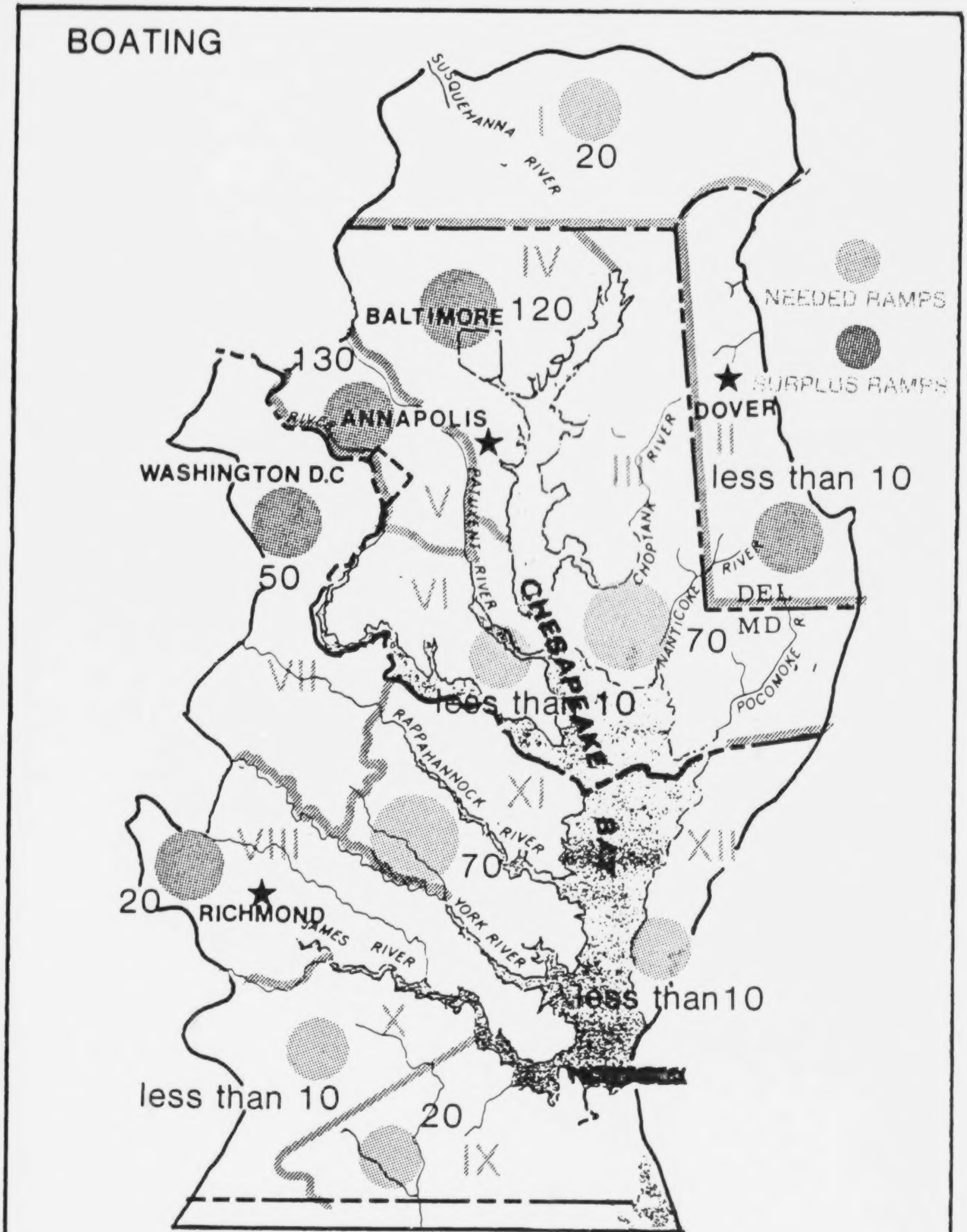
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Other factors interfere with the maximum recreational utilization of the Bay and its tributaries. Water quality has deteriorated in many sections of the tributaries precluding body-contact water recreation. This problem is especially severe in the urban areas where demands are the greatest. For example, the number of bathing beaches in Baltimore County approved for operation by county health officials has declined from 21 in 1966 to 6 in 1976.

The stinging sea nettle and the closely related comb jellies or ctenophores which reach peak abundance in the summer months also discourage water contact recreation. Other deterrents to recreation activities include the existence of extensive and often valuable wetlands and the occasionally objectionable growth of certain aquatic plants such as the Eurasian Watermilfoil and water chestnut which inhibit boating and swimming.

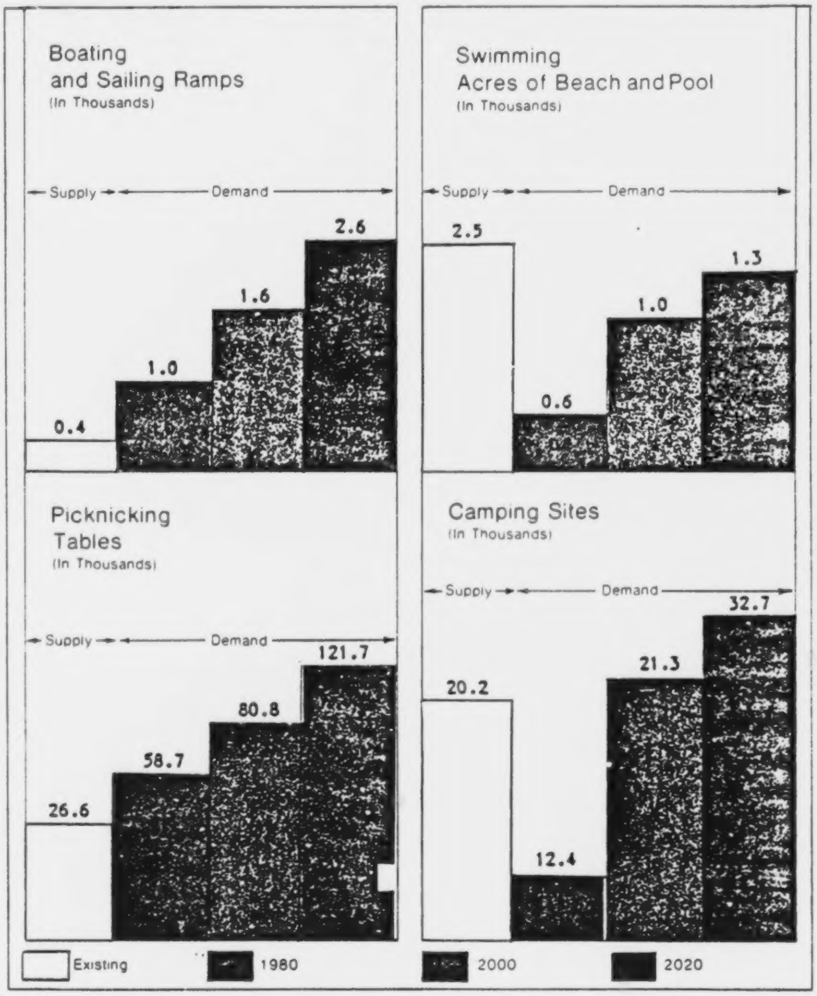
Recreational use of the Bay and its tributaries has created problems and conflicts in itself. For example, many boaters are responsible for degrading water quality by dumping refuse overboard, discharging sewage effluent, and spilling gas and oil into the water. The result is unsightly debris, and in some cases, the closing of certain areas to both water-contact recreation and shellfish harvesting. In addition, recreational boating frequently conflicts with other aquatic activities such as swimming, fishing, commercial shipping, and private shore front property use (brought about by erosion of the shoreline from boat wakes). Finally, recreational boating has led to overcrowding of certain waterways, particularly those most accessible to the large urban areas. This has created dangerous, undesirable conditions for both boaters and swimmers.

FUTURE DEMAND AND SUPPLY

Figure 21 illustrates the relationship between existing supply and projected demand for boating and sailing, swimming, picnicking, and camping in the Study Area. As can be seen, the demand for boating ramps is expected to exceed the existing supply by almost six times by the year 2020. Most of the increase in demand is expected to occur in the three subregions surrounding Baltimore and Washington. These subregions are also projected to have the most critical supply deficits in 2020 with 1,150 ramps needed. A major supply deficit in 2020 is also expected in the Richmond subregion. The only subregions predicted by BOR to have a surplus of ramps through the year 2020 are the Eastern Shore of Maryland and Virginia and the Tidewater portion of Virginia. Of the total demand for boating ramps in 2020, almost 22 percent of the total will be accounted for by non-resident demand.

The need for swimming beaches and pools is also expected to increase significantly during the next 50 years. Although the entire Study Area has a supply excess over the projection period, supply deficiencies in the Baltimore, Washington, and Richmond metropolitan areas are expected to increase from approximately 200 acres of beach and swimming pool water surface area in 1980 to almost 400 acres in 2000 and over 550 acres in the year 2020. Large supply surpluses were projected for the Maryland and Virginia Eastern Shore, Delaware, and Hampton Roads subregions. These surpluses, however, were due to the large expanses of ocean beaches in these areas. Access to these beaches may be a problem for many Study Area residents due to financial and/or transportation constraints. This is especially true for many low-income families in the urban areas where supply deficits are most acute. Non-resident demand

Figure 21: Projected Demand and Existing Supply for Boating and Sailing, Swimming, Picnicking, and Camping, Chesapeake Bay Region (Resident and Non-Resident)



is expected to account for 22 percent of the total swimming demand throughout the projection period.

In 1970, there was a total of approximately 26,600 picnic tables in the Chesapeake Bay Study Area which was 24,800 tables short of the total resident and non-resident demand in the same year. By the year 2000, this is expected to increase to over 54,000 picnic tables and by 2020 approximately 95,000 tables. Typically, the greatest projected shortages are in the major urban areas of Baltimore, Washington, Hampton Roads, and Richmond. Moderate surpluses were projected for the Southern Maryland and Virginia Eastern Shore subregions. Non-residents will exert demands on picnic facilities which are expected to amount to a fairly constant 25 percent of total demand over the projection period.

The entire Study Area has a surplus of 11,400 camping sites with only the Washington and Baltimore areas showing current supply deficits. By the year 2000, however, there is projected to be a supply deficit of approximately 1,100 sites and by 2020 there is expected to be a need for over 12,500 sites. Once again, the Baltimore and Washington Metropolitan areas are expected to experience the largest deficits with resident demand alone in 2020 amounting to five and one-half times the existing supply. Existing camp sites in Hampton Roads, Tidewater Virginia, Petersburg-Hopewell, and the Eastern Shores of both Maryland and Virginia are expected to be sufficient to meet resident demands through the projection period. Non-resident demand for camping in the Study Area is estimated to be approximately 25 percent of total demand throughout the projection period. For more information on projections of facility requirements by subregions, see Appendix 8 of this Report.

MEANS TO SATISFY NEEDS

If it is assumed that meeting future outdoor recreation needs within the Study Area is desirable, then there exists a number of means to help satisfy future boating and sailing, swimming, picnicking, and camping needs. The vast amounts of underutilized water-related land resources in the Study Area could be used for much of the future recreation activities. Among the underutilized resources are vast stretches of shoreline controlled by the Federal Government.

These areas include large tracts of military lands such as Aberdeen Proving Ground, Edgewood Arsenal, Quantico Marine Base, Fort Story, and Camp Peary Military Reservation. The "Baltimore Urban Recreation Analysis" prepared by BOR contains information and general findings directly related to the use of Federal and military lands in the Baltimore subregion. The report states that, "despite the more than 840 miles of shoreline in the Baltimore SMSA, less than 1.5 percent of the shoreline is available for public recreational use." Also, the Baltimore Regional Planning Council's document, "Chesapeake Bay: Shoreline Utilization in the Baltimore Region," reports that 12 percent of the Baltimore regional shoreline is in military use. Although it is recognized that it is not possible to open all of these military lands to the public for recreational use, the fact remains that they represent a very significant untapped resource.

Watersheds and water supply reservoirs also offer significant potential for multiple uses. Many of the water supply reservoirs and their adjacent lands are located on attractive, wooded upland sites which offer the potential for swimming, boating, picnicking, and camping. In the past, public health constraints, administrative policy and public opinion have discouraged or prevented joint use of water supply reservoirs. However, existing restrictions should be reexamined in the light of modern water treatment technology to determine if they are essential.

Land adjacent to river channels can also serve as a substantial additional resource base to meet recreation needs. The use of flood plain lands in urban areas for a variety of quality recreational experiences may also preclude development on those flood plains and thus reduce future flood losses. Harbor redevelopment and multiple use of waterfront areas in urban centers is another valuable source of recreation lands. These multi-use areas, which in many cases have become rundown and underutilized, could prove especially significant as recreation areas since they are adjacent to large populations.

Another excellent opportunity to meet outdoor recreation needs in the Chesapeake Bay Study Area is the further development of wild and scenic and recreational river systems. Rivers preserved in their natural free-flowing state offer a wide variety of recreational potential for such activities as canoeing, kayaking, rafting, and boating. In addition, the scenic vistas usually located near these rivers can provide ample opportunity for outdoor recreation pursuits including picnicking and camping. The States of Maryland and Virginia have enacted legislation aimed at the protection of some of the wild and scenic rivers within their State boundaries. Maryland adopted a policy which protects the water quality of certain designated rivers within the State and fulfills vital conservation purposes by wise use of resources within the scenic river system. Currently, eight rivers have been designated as scenic within the State. The Virginia General Assembly enacted the Scenic Rivers Act in 1970 to help coordinate efforts between Federal and State agencies to insure comprehensive water resource planning. To date, 10 Virginia rivers have been designated either scenic or potential scenic rivers. The former group will thus be protected for the enjoyment of present and future generations.

Public acquisition of new land for recreational use is frequently necessary, particularly in urban areas, where demand is great and existing recreational areas may be in extremely short supply. To accomplish such acquisition, funding at all levels of government will have to be increased, particularly in view of the escalating price of land.

An alternative to the costly purchase of new recreation lands is the expansion, intensification of use, and improvement of existing recreation lands. In taking such action, however, care is required to avoid creating overcrowded conditions or befouling recreational facilities to the point where they can no longer be enjoyed by anyone. Many of the existing recreational facilities within or adjacent to the Bay Region's urban areas are in particular need of intensification of use, where physically possible.

Three legislative measures have been found most effective in implementing a program of preserving, maintaining, and acquiring recreation lands to satisfy future outdoor recreation needs. These include zoning, which imposes land use restrictions; tax incentives to preserve open space lands for public use; and eminent domain which condemns private land for public use. By use of these three legislative actions, lands can be obtained or preserved for recreational use before residential or commercial development pressures occur. For example, in areas where vacation homes are popular, residential development around a community waterfront park area could be encouraged to facilitate maximum use and benefit from waterfront lands. Properly planned and spaced marinas, a legitimate use of waterfront lands, could be given a higher priority than shopping centers, for example, at the water's edge. Commercial development not dependent upon water access could be located inland.

Meeting all future outdoor recreation needs may not be an entirely desirable goal. As discussed in the "Problems and Conflicts Section" above, recreation in the Bay Region has created certain problems including water pollution, conflicts in use of the aquatic environment, and overcrowding of waterways. As future recreation demands increase, these problems can also be expected to increase. By providing alternative outdoor recreation opportunities, however, the intensity of these problems can be reduced. In addition, the provision of recreation alternatives would serve to help meet the recreation needs in the Study Area.

One important alternative means for meeting recreation needs is the development of recreation trails which would substantially add to the resource base in the Chesapeake Bay area. Because of the rich archeological, historical, and natural resources of the Bay Region, a trail system might include biking or hiking trails which would perhaps contribute to the tourism industry. The scenic rivers and their adjacent shoreline areas could provide opportunity for recreation pursuits ranging from nature walks to birdwatching. Outdoor games and sports such as tennis, golf, and horseback riding are other possible alternative means to help satisfy future recreational demands in Chesapeake Bay.

SECTION III

NAVIGATION

CURRENT STATUS

Transportation by water has changed drastically since Colonial times when oceangoing 500-ton sailing ships with 10- to 15-foot drafts plied the Chesapeake docking at individual plantation piers. Water-based transportation, however, has remained extremely important to the Chesapeake Bay Region's economy. A total of approximately 160 million short tons of cargo was shipped on Chesapeake Bay during 1974, nearly three-quarters of a ton for each man, woman, and child in the United States. About 80 percent of this freight passed through the ports of Baltimore or Hampton Roads. Approximately 70 percent of the total freight traffic in these two ports is foreign in origin or destination. Baltimore is basically an importing port. The major commodities coming into Baltimore are metallic ores and concentrates, petroleum and petroleum products, gypsum, sugar, iron and steel products, salt, and motor vehicles and motor vehicle equipment. The port leads the Nation in the importing of automobiles and ranks second in iron ore. The majority of these imported bulk commodities are processed by firms in the Baltimore area.

Hampton Roads, on the other hand, is an export-oriented port. Approximately 70 percent of the total freight tonnage passing through Hampton Roads in 1974 was coal and lignite to be exported. Hampton Roads leads the Nation in this category. The port's location in relation to the coal-rich Central Appalachians gives the port a locational advantage over the other East Coast ports in the coal exporting business. Hampton Roads also conducts important trade in the exporting of corn, wheat, soybeans, tobacco leaf, and grain mill products, as well as in the importing of petroleum products, gypsum, lumber and wood products, and chemicals.

These two Nationally significant ports also have important impacts on the regional economies. For example, according to the Maryland Port Administration (MPA), 65,000 workers are directly employed by port activities in the Baltimore area and another 100,000 in "port-related" industries. A similar study in Virginia for all the Virginia ports revealed that more than 53,000 people were directly employed by port-related activities and another 142,000 by "harbor-oriented" activities including naval installations.

Although Baltimore and Hampton Roads are the only major international deepwater ports in the Chesapeake Bay Area, there is also a significant amount of traffic in the harbors of some of the smaller ports such as Richmond, Yorktown, Hopewell, Petersburg, and Alexandria, Virginia; Piney Point, Annapolis, Salisbury, and Cambridge, Maryland; and Washington, D.C. The major commodities shipped through these ports are petroleum and petroleum products, construction materials, fertilizers, and seafood.

Due to the increasing size of oceangoing vessels during the past 100 years and the economies involved in the use of these ships, repeated deepenings and widenings of Chesapeake Bay's ship channels have been necessary. In the Port of Baltimore, for example, there have been many improvements made by the Federal government, the most notable being the authorized deepenings to 27 feet in 1881, 35 feet in 1905, 37 feet in 1930, 39 feet in 1945, and 42 feet in 1958. More recently, Congress has authorized an additional deepening of the main channels to 50 feet. In Hampton Roads there have also been numerous improvements of the area's many channels, starting in 1884. The main channel into Hampton Roads was deepened for the first time in 1907 to 30 feet, again in 1910 to 35 feet, in 1917 to 40 feet, and finally in 1965 to 45 feet.

In the Chesapeake Bay and its tributaries there are a total of 147 authorized navigation projects under the supervision of the Baltimore and Norfolk Districts of the Corps of Engineers. The State of Maryland has constructed 16 navigation projects in the Chesapeake Bay and tributaries. There are no State projects in Virginia.

Due to the high sediment loads present throughout most of the Chesapeake Bay system, many of the ship channels are in frequent need of dredging to maintain authorized depths. The frequency of maintenance dredging depends on the location of the waterway. Some waterways, such as the James River, require maintenance almost every year. On the other hand, the Rappahannock Shoal Channel (part of the Baltimore Harbor and Channels Project) has not been maintained since its deepening to 42 feet in 1964.

Two types of dredge material disposal have generally been used in the past in Chesapeake Bay—open water disposal and disposal in dyked impoundments. In the Upper Bay, open water disposal has been used. Uncontaminated dredge material was generally placed near the northern shore of Kent Island while contaminated material was disposed of in the Pooles Island area. In the lower Bay, the Craney Island Disposal Area has been used for all major dredge disposal operations for the Hampton Roads channels. The Craney Island site, constructed in 1957, is a Federally-authorized project located in the heart of the Hampton Roads port complex. The dyked area, which covers about 2,500 acres and has a capacity of about 125 million cubic yards, is expected to be filled to its design height of 17 feet above mean sea level by about 1980.

EXISTING PROBLEMS AND CONFLICTS

The major problems and conflicts relative to navigation and waterborne commerce in the Bay Region include:

a. The need for deeper channels to accommodate the larger ships now in the world fleet.

b. The maintenance of existing channel depths because of sedimentation and shoaling.

c. The disposal of dredge material from both the maintenance and the deepening of channel projects.

d. Accidental and deliberate discharges of wastes from commercial and recreational craft.

e. Shoreline erosion caused by the wakes from large ships.

f. Conflicts between recreational boating and commercial ships in or near the major ship channels.

g. Need for additional waterfront lands to accommodate expanding port facilities.

The first two problems mentioned above stem from a basic confrontation between man's water transportation requirements and the Bay's geological nature. For example, because the Chesapeake Bay is a relatively shallow body of water, major channel deepening projects designed to accommodate today's larger, more efficient ships require extensive dredging. In addition to the natural shallowness of the Bay, Nature's tendency to fill the Estuarine system with sediments and to convert it back to a riverine system causes many existing channels to experience shoaling problems. Dredging and dredged material disposal operations are consequently an important and necessary part of commercial navigation activities on Chesapeake Bay and its tributaries. The environmental impact of these operations has become a very controversial issue. The principal environmental effects of the actual dredging operation are:

1. Removal by either dredging or filling of the original interface between the water and the bottom, which can be an area of high biological activity. In most cases, the effects of removal of the existing sediment-water interface are usually localized and of relatively short duration. The circulation patterns of the Bay's waters usually provide opportunities for the reestablishment of available species within one or two years. It should be emphasized, however, that exceptions do occur (e.g., oysters because of their need for a hard bottom) and that a thorough analysis should be conducted if complications are to be avoided.

2. Changes in bottom contours, which may affect current and salinity patterns. In general, the creation of deepwater areas causes further saltwater intrusion. Saltwater intrusion can cause complex changes in an estuary's ecosystem. These changes may involve both beneficial influences such as the improved upstream transport of young crabs, fish, and other species as well as detrimental impacts such as greater penetration of oyster predators and parasites. The net effect will vary with the location and magnitude of the dredging activity as well as the season.

3. Turbidity caused by dredging can create various problems. Suspended sediments can clog and damage the gills of many kinds of animals, reduce photosynthetic activity, and reduce the buoyancy of eggs of marine animals. As the sediments settle, a coating may form on the bottom interfering with the attachment of young oysters to the beds and creating soft bottom layers that are uninhabitable for many benthic species. On the other hand, such sediments frequently occur naturally in estuaries and coastal waters, and many species can tolerate considerable quantities of suspended material. Sediments can also be beneficial to many types of organisms by providing the type of substrate needed by some animals and by carrying nutrients into the marine system.

With regard to the problems associated with the disposal of dredged material, the major channels for Baltimore and Hampton Roads and the approach channels to the Chesapeake and Delaware Canal are by far the major problem areas. If for no other reason, the sheer volume of material that must be removed during either periodic maintenance or an overall deepening of these major projects creates disposal problems. There are also significant environmental problems associated with dredged material disposal.

Perhaps the most serious environmental problem, and certainly the most emotional, occurs when the dredged material is contaminated by industrial or municipal wastes. Heavy metals, such as mercury, zinc, and lead, along with such substances as pesticides and nutrient salts can have harmful and even toxic effects on aquatic life. There is very limited information on how available such materials become to the marine environment in various chemical forms once they reenter the water. For example, heavy metal contaminants may be tightly bound to the sediment particles physically or chemically, or at the other extreme, simply dissolved in the water mixed with the sediment. The soon to be completed Dredged Material Research Program being conducted at the Corps of Engineers Waterways Experiment Station (WES) in Vicksburg, Mississippi, is conducting research into these types of problems. Another source of conflict between waterborne commerce activities and environmental quality is the deliberate discharge or accidental spilling by vessels of oil, garbage, sewage, and other wastes into the Bay. Unfortunately, these discharges and spills often occur in congested harbor areas with poor flushing action which causes further degradation of often already poor water quality. Although the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) prohibit the discharge of harmful quantities of oil or hazardous substances in the waters of the United States, there is probably no practical way to stop the element of human error. A valve not completely closed, a lack of attention while filling tanks, or worst of all, tanker collisions, could have disastrous environmental, as well as economic, consequences.

Waterborne commerce-related activities can also have significant impacts on other aspects and uses of the Chesapeake Bay resource. First, the wave action caused by passing ships is a major cause of erosion in some areas of the Bay. Second, recreational fishing and boating can be disrupted by the wakes from passing ships. In addition, large areas of the Bay and its tidal tributaries are precluded from recreational uses because of their use as anchorages, ship channels, or dredge disposal areas by commercial navigation interests and/or the military. On the other hand, large commercial and military vessels must be constantly on the alert for the smaller recreational vessels to avoid collisions or swampings. Lastly, the development of a major port is dependent on the concurrent development of land-based port-related facilities. However, the development of shoreline land for terminal facilities may in some cases conflict with existing wetlands or proposed recreational use of the same land. Also, port-related facilities, because of their locational requirements, may be subject to tidal flooding and shoreline erosion.

EXISTING AND PROJECTED DEMANDS

The following sections present the projected waterborne commerce demands on a commodity group basis for the individual ports and waterways considered in this study. Due to the type of analysis, it was considered to be appropriate that additional existing information also be presented with the projected demands.

In addition to the Ports of Baltimore and Hampton Roads, projections were prepared for those Chesapeake Bay waterways with over 200,000 short tons of commence in 1970. Because of the differences in relative importance to the Chesapeake Bay Region and the Nation of the various harbors and waterways included in this analysis, projections were made to varying degrees of detail. Baltimore and Hampton Roads were analyzed in depth on a commodity group and in some cases an individual commodity basis. On the other hand, projections for several of the smaller waterways (in terms of tonnages) were made for two groups only—bulk oil and the total of all other commodity groups.

There are essentially three types of waterborne movements addressed in this analysis—foreign, coastwise, and internal. Foreign imports and exports refer to traffic between the United States and foreign ports. Coastwise receipts and shipments apply to domestic traffic receiving a carriage over the ocean, or the Gulf of Mexico (e.g., New Orleans or Puerto Rico to Baltimore). Internal receipts and shipments are confined to inland waterways such as Chesapeake Bay.

a. *Baltimore Harbor:* As shown in Figure 22, bulk commodities, especially petroleum and ore, are expected to continue to dominate waterborne traffic in the Port of Baltimore. General cargo movements, however, are expected to increase significantly over the projection period so that by 2020 the tonnage moved is expected to be higher than any other single commodity category.

The industrial, commercial, and residential complex surrounding Baltimore consumes huge amounts of petroleum fuels for heating, processing, and transportation purposes. The most important bulk oil commodities are residual fuel, gasoline, and distillate fuel. Approximately 90 percent of the bulk oil movements were inbound from the Caribbean area, the U.S. Gulf Coast, or the Delaware River. The remainder were barge shipments, mostly to points within Chesapeake Bay. The tankers from the Caribbean areas are typically in the 25-55,000 deadweight ton (dwt) size with up to 39-foot drafts. Tankers from the Gulf Coast range in size up to 75,000 dwt with 42-foot drafts.

Baltimore's large primary metals industry is dominated by the Bethlehem Steel Corporation, which employs roughly three-quarters of the workers in the industry. As a result, about 93 percent of the metallic ore imports in 1972 consisted of iron ore used in the production of steel. The ships carrying iron ore into Baltimore are the largest that call on the Port. The average iron ore vessel is in the 40-60,000 dwt range with 38 to 42-foot drafts. Vessels of this size use the existing 42-foot channel to the maximum extent. Occasionally vessels of well over 100,000 dwt bring iron ore into the Port although they are not able to fully load due to channel depth restrictions. Aluminum, manganese, chromium, and other non-ferrous ores and concentrates comprise the remaining 7 percent of metallic ore imports. Imports of non-ferrous metals are projected to increase at the same rate as iron ore imports.

Because of its proximity to the Appalachian coal fields in northern West Virginia and Pennsylvania, Baltimore is one of the leading coal exporting ports in the United States. Approximately 90 percent of the coal shipped out of Baltimore is used in the production of coke for foreign steel industries, mainly in Japan and Western Europe. The remainder is used in electric power generation. The average vessel exporting coal out of Baltimore is in the 35-55,000 dwt range with 37 to 42-foot drafts, although bulk coal carriers up to 120,000 dwt with 47-foot drafts have called on the Port. Again, due to channel depth restrictions, these vessels are not able to load to capacity.

In 1972, Baltimore exported approximately 2.9 million short tons of grain, although the average annual export for the last 5 years of record was only 1.5 million short tons. The major types of grain exported in 1972 were corn (45 percent) soybeans and soybean meal (40 percent), and wheat (13 percent). Over two-thirds of the grain exported from Baltimore in 1972 was destined for Western Europe. Because of the relatively small volumes of grain exported through Baltimore, the average size vessel calling on the Port for grain (15-30,000 dwt with 28 to 35-foot drafts) is significantly smaller than the standard world fleet grain carriers. Occasionally, however, much larger vessels enter the Port to load grain for export.

The miscellaneous bulk category for Baltimore Harbor contains such commodities as gypsum, sugar, salt, molasses, sulfuric acid, and fertilizer products. Approximately 72 percent of the movements of these commodities in 1972, were foreign imports with an additional 17 percent classified as domestic receipts. Practically all of these inbound movements were raw or partially processed materials shipped to Baltimore for further processing by factories in the Port area. These activities are especially important to the local economy because they generate jobs and income. Except for sugar imports, which are expected to remain constant over the projection period, the other commodities in the miscellaneous bulk category are projected to exhibit moderate increases in the level of shipments. The vessels carrying miscellaneous bulk commodities are not as large as those carrying petroleum, coal, ore, or grain. The largest vessels are about 35,000 dwt with up to 37 foot drafts but the average is much smaller.

Approximately two-thirds of the total general cargo commerce through the

Figure 22: Projected Waterborne Commerce - Baltimore Harbor

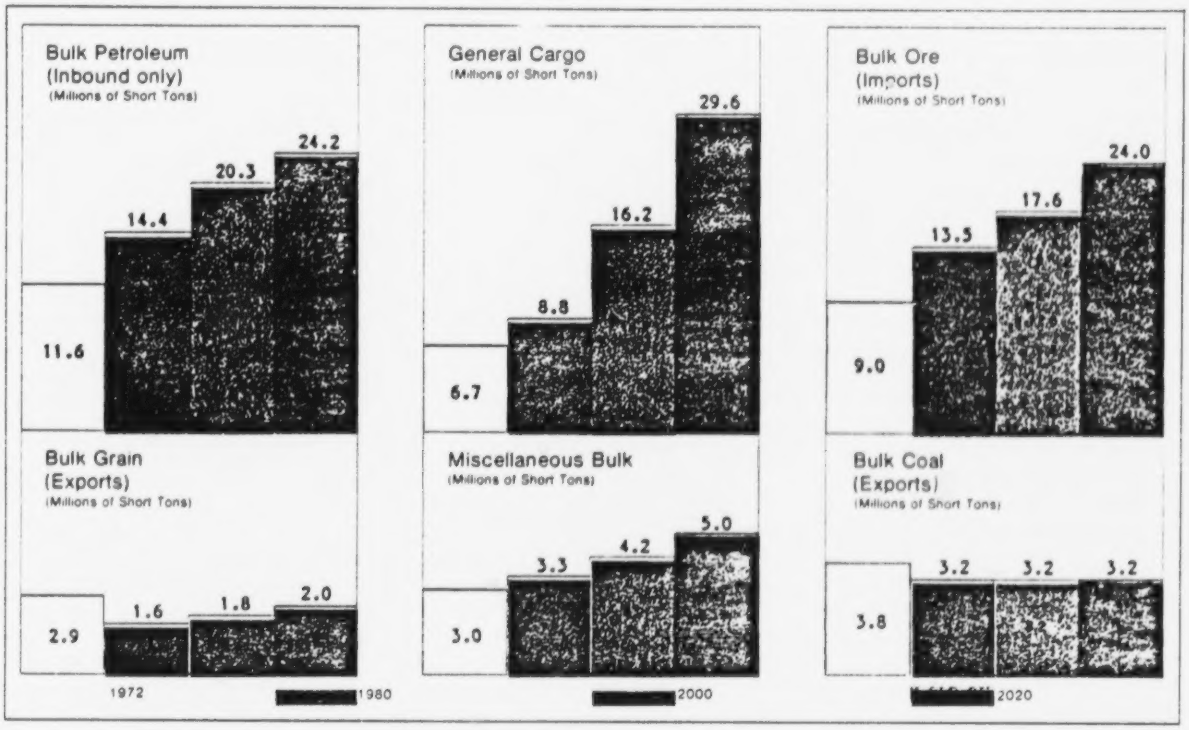
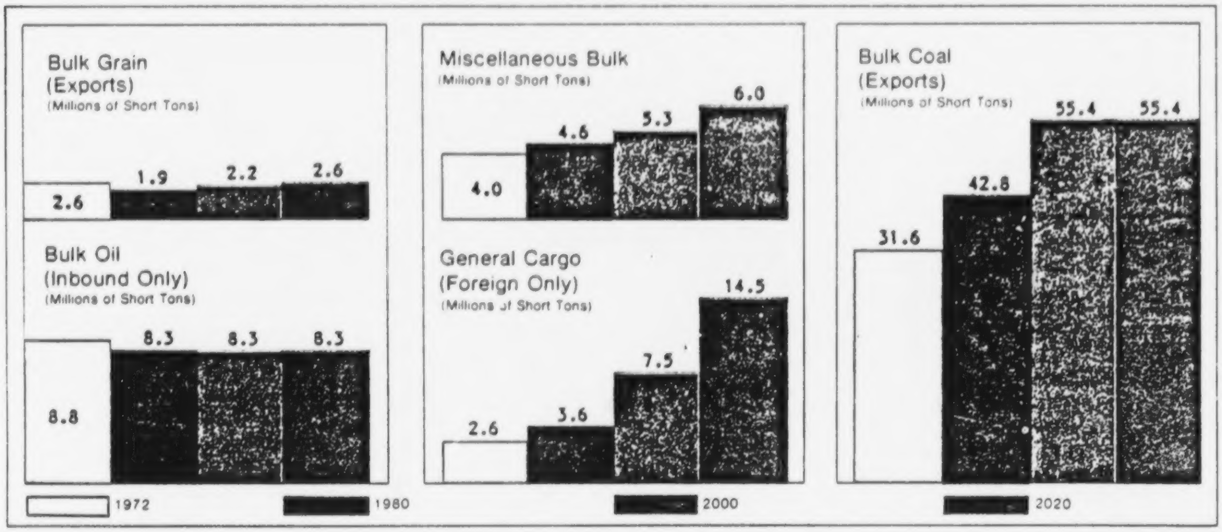


Figure 23: Projected Waterborne Commerce - Hampton Roads



Port in 1972 was foreign in origin or destination. All of the increase in waterborne movements of these commodities is expected to be foreign traffic. The majority of the projected general cargo commerce is expected to be containerized. Domestic movements of general cargo are not expected to increase over the projection period due to stiff competition from railroads and trucks in the movement of often time-sensitive general cargo commodities. The major foreign and domestic general cargo commodities shipped through Baltimore are listed in Table 24. Most of the container ships currently calling on Baltimore are in the 15,000-20,000 dwt range with drafts between 28 to 32 feet.

b. *Hampton Roads:* Figure 23 shows that the export of coal will continue to dominate waterborne commerce during the projection period. As in the case of Baltimore, general cargo movements are expected to show highly significant increases over the projection period. Waterborne movements of commodities in the remaining categories are expected to decrease slightly or show only moderate increases over the projection period.

The most important commodities within the bulk oil group were residual fuel, gasoline, and distillate fuel, accounting for about 92 percent of the bulk oil waterborne movements in 1972. Approximately three-quarters of the bulk oil passing through the port complex is either foreign or domestic inbound. Most of the remaining movements consist of petroleum distributed from Hampton Roads by barge to points within Chesapeake Bay. The major reason for the projected decline in the level of inbound bulk oil movements to Hampton Roads is the expected significant planned cutbacks in residual fuel use by public utilities. This type of use accounted for approximately one-half of the total petroleum consumption in the area in 1972. Increases in gasoline and distillate fuel movements are expected to almost offset the decreases in residual use.

Vessels carrying bulk oil commodities into Hampton Roads are generally about the same size as those calling on the Port of Baltimore (i.e., up to

TABLE 24
MAJOR GENERAL CARGO COMMODITIES
AND TYPE OF TRAFFIC, BALTIMORE HARBOR, 1972

Foreign	Tons (Thousands)	Percent of Total
Bananas and Plantains (I)	383	8.5
Lumber (I)	380	8.4
Metal Products (I & E)	1,272	28.3
Standard Newsprint (I)	100	2.2
Miscellaneous Chemicals (I & E)	294	6.5
Cars and Other Transportation Equipment (I & E)	500	11.1
Machinery (I & E)	285	6.3
Other Miscellaneous	1,301	28.7
Total	4,515	100.0
Domestic		
Metal Products (S)	1,175	54.2
Miscellaneous Chemicals (S)	216	10.0
Agricultural, Food, and Marine Products (R & S)	174	8.0
Lumber (R)	86	4.0
Other Miscellaneous	514	23.8
Total	2,165	100.0

I = Imports E = Exports R = Receipts S = Shipments

TABLE 25
MAJOR FOREIGN GENERAL CARGO COMMODITIES
AND TYPE OF TRAFFIC, HAMPTON ROADS, 1972

	Tons (Thousands)	Percent of Total
Lumber, Veneer, Plywood, and Other Wood Products (I & E)	246	10.6
Tobacco Leaf (I & E)	233	10.0
Machinery (I & E)	156	6.7
Motor Vehicles (I & E)	103	4.4
Basic Textile Products (I & E)	131	5.6
Metal Products (I & E)	268	11.5
Pulp and Paper Products (I & E)	118	5.1
Vegetable Oils, Margarine, Shortening (E)	88	3.8
Miscellaneous Chemicals (I & E)	88	3.8
Other Miscellaneous	897	38.5
TOTAL	2,328	100.0

I = Imports E = Exports

75,000 dwt with 42-foot drafts from the Gulf Coast refineries and usually between 25-55,000 dwt with up to 39-foot drafts from the Caribbean). These vessels, however, can normally enter Hampton Roads loaded to a deeper draft due to deeper channel depths, higher tidal range, and higher salinities.

Hampton Roads is the most strategically located port in the United States with respect to the rich Appalachian coal fields. Hampton Roads annually accounts for about 90 percent of the total U.S. overseas export. Approximately 90 percent of the coal exports leaving Hampton Roads consist of bituminous coal for the production of coke for metallurgical purposes with the remainder being used for electric power generation. About one-half of these exports in 1972 were shipped to Japan with the majority of the remainder going to Western Europe. The average size vessel carrying coal out of Hampton Roads is in the 50-75,000 dwt range with 38-46-foot drafts. However, vessels of over 100,000 dwt are not uncommon. The largest ship to ever call on the port was a vessel of 169,430 dwt which loaded coal bound for Japan. Due to depth restrictions, the vessel could not fully load.

Although far behind export coal, bulk grain is the second largest export commodity passing through Hampton Roads. Most of the grains exported through the port were grown in the Midwestern and South Atlantic states and are generally shipped to Western and Eastern European countries. The major types of grains handled are corn, wheat, and soybeans and soybean meal. Due to the relatively small volumes of export grain handled at Hampton Roads, the vessels carrying these commodities are significantly smaller than those handling coal. The average vessel is in the 25-35,000 dwt range with 32 to 26-foot drafts, although ships in the 100,000 dwt class occasionally call on the port.

Sand, gravel, and crushed rock accounted for almost one-half of the total movements in the miscellaneous bulk category. Other important commodities are limestone, building cement, and fertilizers. The commodities in this category are raw or partially-processed materials shipped into Hampton Roads from foreign and domestic sources for further processing (most by factories in the port area) or for distribution without processing. Movements of sand, gravel, and crushed rock are by barge while vessels carrying the other commodities generally average around 15,000 to 20,000 dwt with drafts of approximately 30 feet. Slightly over 80 percent of the total general cargo traffic was categorized as either foreign imports or exports. About 60 percent of the foreign traffic was containerized in 1970. These container vessels are generally in the 15,000 to 20,000 dwt range with drafts of between 28 to 32 feet. Table 25 lists the major foreign cargo commodities passing through Hampton Roads.

c. *Chesapeake and Delaware Canal.* Commerce through the C&D Canal is dominated by domestic movements of bulk oil and foreign movements of general cargo which together accounted for approximately 70 percent of the total traffic in 1972. The C&D Canal serves as a major passageway for oceangoing vessels calling at Baltimore. In 1972, approximately 58 percent of the vessels engaged in foreign traffic destined for or leaving Baltimore traveled through the C&D Canal. Figure 24 shows the projected levels of commerce for bulk oil and general cargo. Both types of traffic are projected to show moderate increases over the projection period.

In addition to bulk oil and general cargo, there are significantly smaller quantities of bulk coal, bulk ore, bulk grain, and miscellaneous bulk commodities passing through the C&D Canal. These movements were assumed to remain constant during the projection period at the 1965-1972 average of about 1.1 million short tons although the potential exists for substantial increases if a significant number of Northeastern power plants switch to coal.

d. *James River.* Major flows of traffic on the James River consist of internal barge receipts of bulk oil at Richmond, Hopewell, and the Virginia Electric and Power Company's Chesterfield power plant and internal barge movements of commodities other than bulk oil (mostly sand and gravel). These two traffic flows accounted for 84 percent of the total waterborne movements on the James in 1972.

Figure 25 shows the projections of bulk oil and internal shipments for commodities other than bulk oil for the James. These two commodity categories are expected to continue to dominate James River waterborne commerce in the future accounting for over 90 percent of the total traffic in the year 2020.

There were also oceangoing movements of chemicals and general cargo commodities passing through Richmond and Hopewell which totaled about 500,000 short tons in 1972 but averaged 740,000 tons over the 1970-72 period. Total oceangoing commerce is assumed to remain constant at approximately 740,000 short tons over the projection period.

The oceangoing general cargo vessels calling at James River ports average about 5,000 dwt with about 22-foot drafts, although there are some vessels up to 12,000 dwt with loaded drafts of 30 feet. Most of the dry cargo ships and tankers handling chemicals are in the 20,000 dwt class with loaded drafts of over 30 feet. Since the main channel to the Richmond-Hopewell area has an authorized depth of only 25 feet, the larger vessels are not able to load to capacity.

e. *Potomac River:* Traffic on the Potomac is dominated by the movement of bulk oil into the River to help satisfy the Washington Metropolitan Area's tremendous demand for energy. This type of traffic accounted for approximately 87 percent of the total commerce on the Potomac in 1972. Most of the remaining traffic consisted of internal barge movements of sand and gravel to the Washington area from points along the Potomac River and foreign imports of newsprint into Alexandria, Virginia.

Waterborne bulk oil commodities destined for Washington are handled by the Steuart Petroleum Company's facility at Piney Point, Maryland, approximately 13 miles upstream from the confluence of the Potomac with

Chesapeake Bay. Large oceangoing tankers, most in the 25-55,000 dwt size range with between 35 and 38-foot drafts, as well as barges from domestic sources, carry petroleum products into the Steuart facility where they are unloaded and redistributed by pipeline and barge to the Washington, D.C., and Southern Maryland areas. The Possum Point power plant, owned by VEPCO, is the only major petroleum products user on the river which has fuel sent directly to its plant, bypassing the Piney Point facility.

Despite expected significant decreases in residual fuel use by power plants in the Washington area, the total projected bulk oil imports and receipts at Piney Point illustrated in Figure 26 indicate a sizable increase in bulk oil movements on the Potomac over the next fifty years. This is due to large projected increases in waterborne imports and receipts of gasoline, distillate fuel, and other "clean" petroleum products expected as a result of higher than average increases in income and population in the Washington area in the future.

Traffic other than bulk oil on the River is expected to remain at a fairly constant 500,000 short tons during the projection period.

f. *York River.* The largest oil refinery in the Chesapeake Bay Region is located near the mouth of the York River at Yorktown. Although the 50,000 barrel/day refinery is not large by Delaware River or Gulf Coast standards where plants with capacities of 200,000 barrels/day are not uncommon, the facility still accounted for almost five million short tons of waterborne petroleum commerce in 1972. Total waterborne commerce on the York River in 1972 totaled 6.5 million short tons of which bulk oil commodities accounted for approximately 89 percent of the total. Other major users of bulk oil include a power plant at Yorktown, the only major pulp and paper mill in the Chesapeake Bay Region at West Point, Virginia, and the U.S. Navy at Cheatham. Total bulk oil projections are presented in

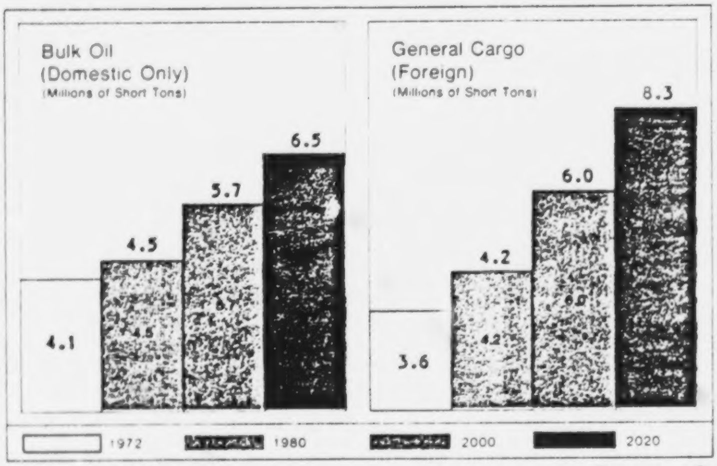


Figure 24: Projected Waterborne Commerce - Chesapeake and Delaware Canal

Figure 25: Projected Waterborne Commerce - James River

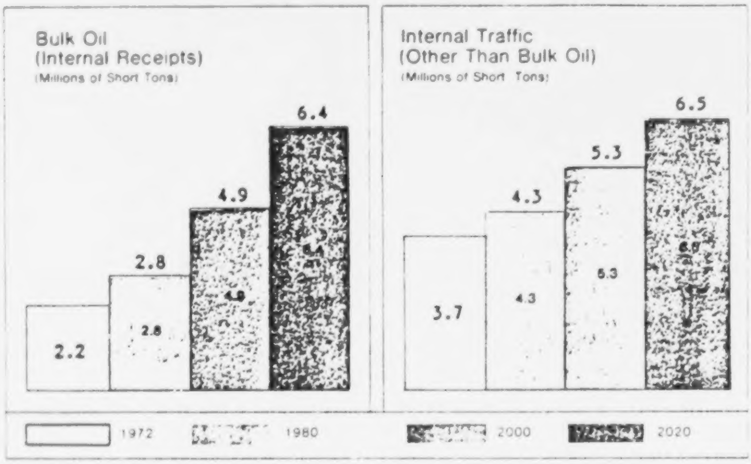


Figure 26: Projected Waterborne Bulk Oil Commerce - Potomac River.

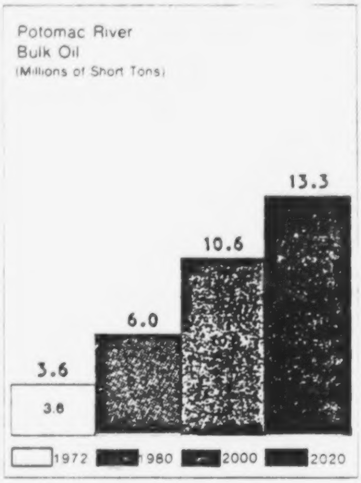


Figure 27: Projected Waterborne Bulk Oil Commerce - York River.

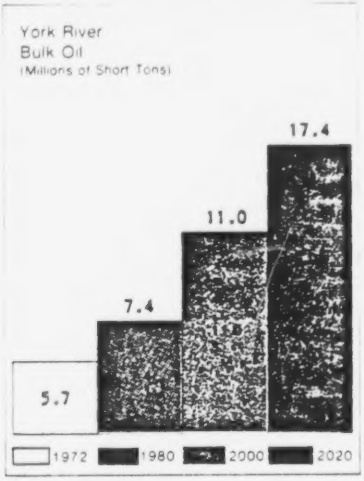


Figure 27. The capacity of the Yorktown refinery is projected to increase to approximately 170,000 barrels/day by 2020.

Most of the vessels carrying crude petroleum into the Yorktown refinery are in the 70,000 dwt class with 41-foot drafts. These ships are unable to fully load due to depth restrictions in the York River approach channel.

g. *Other Waterways.* The Wicomico, Nanticoke, and Rappahannock Rivers are expected to continue to be dominated by inbound barge movements of bulk oil. As shown in Figure 28, the Rappahannock River is expected to experience by far the most significant increases in bulk oil movements of these three waterways mainly due to "spillover" into the area from the fast-growing Washington Metropolitan Area. The Wicomico and Nanticoke Rivers are expected to experience only moderate increases in bulk oil movements over the projection period. Of these three rivers, only the Rappahannock has any significant movements of commodities other than bulk oil. About 40 percent of the commerce on the river consisted of industrial chemicals, pulpwood and seafood. Movements of these commodities on the Rappahannock are assumed to remain constant at the 1970-1972 level of approximately 170,000 short tons.

Figure 28: Projected Waterborne Commerce for Selected Commodities-Wicomico, Nanticoke, Rappahannock, and Choptank and Tred Avon Rivers

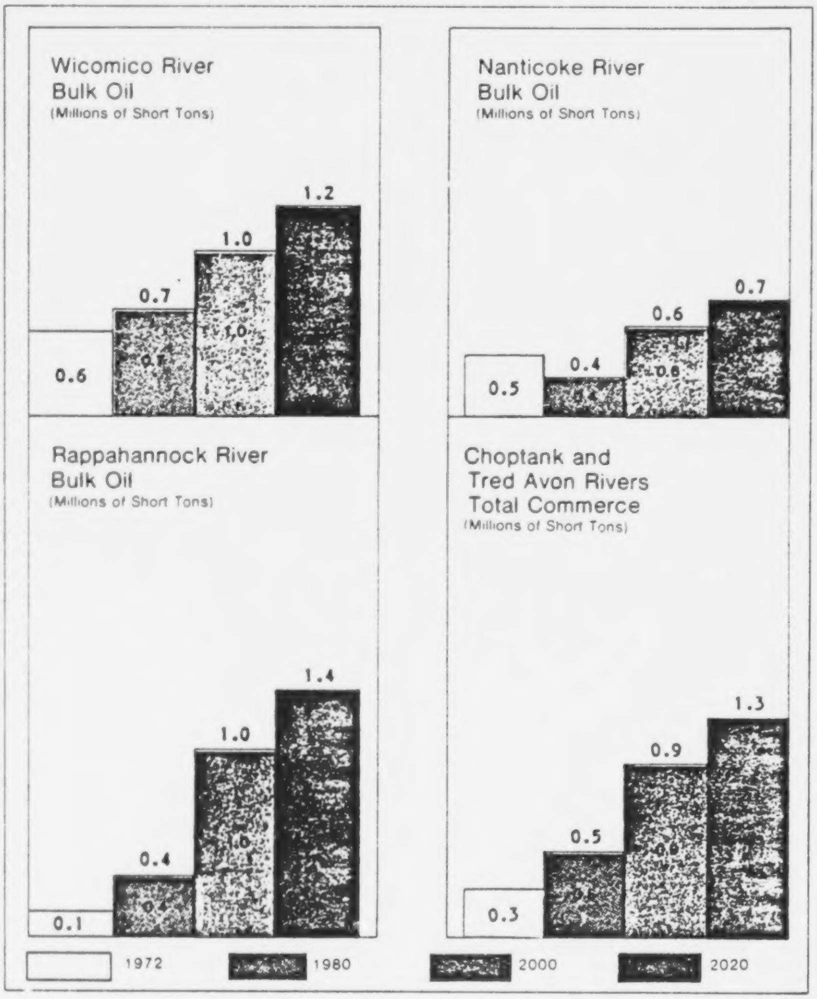


TABLE 26
FEDERALLY AUTHORIZED MAIN CHANNEL DEPTHS AT
SELECTED PORTS AND WATERWAYS, CHESAPEAKE BAY REGION

Port or Waterway	Authorized Depth (feet)
Baltimore Harbor and Channels	50*
Hampton Roads	45
York River Entrance Channel	37
York River (to West Point)	22
James River (to Richmond)	35
Wicomico River (to Salisbury)	14
Nanticoke River (to Seaford)	12
Rappahannock River (to Fredericksburg)	12
Choptank River (to Denton)	8
Tred Avon River (to Easton)	12
Chesapeake and Delaware Canal	35

*Existing depth in main channel is 42 feet.

Virtually all of the traffic on the Choptank River (including the Tred Avon River) was inbound, with about 10 percent being foreign oceangoing imports and the remainder classified as internal barge receipts in 1972. Bulk oil commodities accounted for a relatively small 40 percent of the total waterborne commerce. Other important commodity flows on the Choptank include slag (used for construction purposes), fertilizer, and fresh fish shipped from Iceland to Cambridge for processing. The majority of the projected increase in total traffic on the Choptank River, illustrated in Figure 28, is accounted for by increases in traffic other than bulk oil or fresh fish. Bulk oil movements are expected to show only moderate increases while imports of fresh fish are projected to decline slowly, but steadily, during the projection period. The vessels involved in the importation of fresh fish are refrigerated fishing craft which range in size up to 4,100 dwt with 22-foot drafts. These vessels are able to take advantage of the municipal channel in Cambridge which has a project depth of 25 feet.

FUTURE SUPPLY

METHODOLOGY

The future supply analysis is actually an analysis of the capacity of a harbor or waterway in terms of channel depths. The following section will present a general inventory of existing and authorized channel depths for the major waterways and harbors in the Chesapeake Bay Region. A more detailed listing of channel depths by commodity for each port considered in this analysis is presented in Table 9-6 of Appendix 9 – "Navigation." The basic assumption made in this assessment of future supply is that there will be no further development of the Bay's navigation system beyond the channel improvement projects which are currently authorized. These "without project" projections of supply can then be compared to the "with project" demand projections to identify specific areas or types of uses where future use may be greater than the existing capacity of the resource.

CHANNEL CAPACITIES

There are a great variety of channel depths in Chesapeake Bay and its tributaries. Baltimore and Hampton Roads contain the only major deepwater ports in the Study Area with existing main channel depths of 42 and 45 feet, respectively. The dimensions of both public and private branch channels within these port complexes vary considerably. With the exception of the Chesapeake and Delaware Canal, which primarily serves the Port of Baltimore, and the York River Entrance Channel, which handles petroleum products, the remaining Federal channels are 25 feet in depth or less and handle barge traffic almost exclusively. Table 26 lists the Federally authorized main channel depths for the ports and waterways for which projections were prepared in this study.

The deepening of the main channel to Baltimore to 50 feet was authorized by Congress in 1970. Preconstruction planning for this project has recently been initiated. In addition, the Baltimore District has recently completed a study recommending that the Federal government assume the responsibility for the maintenance of the 25-foot municipal channel at Cambridge, Maryland and the Tred Avon River was recently dredged from the old channel depth of 8 feet to the new project depth of 12 feet.

Although dredging of the C & D Canal to the new project depth of 35 feet from 27 feet was recently completed by the Philadelphia District of the Corps of Engineers, the approach channel to the Canal from Baltimore has experienced serious shoaling. The newly deepened C & D Canal cannot be used efficiently unless the approach channel is dredged to the 35 foot project depth.

Although an authorized depth of 35 feet was authorized for the James River in 1962, a follow-up study completed in 1972 found that dredging to the 35-foot depth was no longer economically justified.

FUTURE NEEDS AND PROBLEM AREAS

There are several types of commodity movements on Chesapeake Bay in which the existing channels are unable to handle present or projected ship sizes without serious losses in economic efficiency. These losses develop when large vessels must enter or leave a port only partially loaded because of depth limitations. When these efficiency losses are severe enough to outweigh any competitive advantage an area might have for the movement of a certain commodity, severe economic consequences may result. In the case of imported raw materials processed in the port area, economic losses may be severe enough to cause cutbacks in production or even plant closings resulting in the loss of jobs, income, and tax revenues to the region.

The most critical commodity movements in terms of existing or potential inefficiencies through the Ports of Baltimore and Hampton Roads are the bulk commodities such as iron ore, coal, grain, and petroleum products. Most of the larger vessels carrying these commodities into the two ports cannot fully load or must lighter before entering the harbor.

In the case of Baltimore Harbor, the authorized 50-foot project, if constructed, will eliminate most of these inefficiencies. Despite the very large increases expected in containerized traffic in Baltimore, channel depths are not expected to be a constraint due to the relatively small size of containerships when compared to the world fleet of tankers and ore carriers.

Another major navigation-related problem in the Baltimore Harbor area is the disposal of dredged material. Maintenance dredging by the Corps of Engineers and other public and private interests has been repeatedly delayed because of the lack of agreement on an economically and environmentally acceptable disposal site for the dredged material. The magnitude of the disposal problem is immense. If the 50-foot project is completed, it is estimated that approximately 150 million cubic yards of dredge material will have to be disposed of during the next 50 years (including maintenance). This quantity of material is sufficient to cover the entire City of Baltimore to a depth of approximately 2 feet. A suitable disposal site will be identified during preconstruction planning for the 50-foot project.

In the Hampton Roads area, inefficiencies in the movement of export coal, grain, and some of the miscellaneous bulk commodities would be greatly alleviated if a deeper channel were to be authorized and funded. The Norfolk District of the Corps of Engineers is currently investigating the feasibility of deepening the Hampton Roads channels. A deeper channel might also benefit the movement of crude oil through Hampton Roads to the refinery at Yorktown on the York River by allowing larger tankers (i.e., up to 90,000 dwt) to enter Hampton Roads where they can be lightered for the trip to Yorktown. One disadvantage of this plan would be the possibly damaging environmental consequences of a major oil spill during these lightering operations.

As in the Baltimore Harbor case, the container vessels carrying general cargo in and out of Hampton Roads are not expected to increase significantly in size in the foreseeable future. Therefore, it is not expected that channel depths will be a significant constraint to the movement of containerships through Hampton Roads.

The dredge material disposal situation has not been nearly as critical in the Hampton Roads area as in Baltimore. This is due to the existence of the Craney Island Disposal Area. The site is nearing its capacity, however, with complete filling expected around 1980.

The seriousness of this approaching problem becomes evident when it is noted that maintenance dredging alone between 1980 and 2020 will produce approximately 150 million cubic yards of material to be disposed of or utilized in some manner. If, for example, a 55-foot channel deepening alternative is undertaken, the total dredged material involved increases to approximately 280 million cubic yards by the year 2020 (assuming a 10-year development period).

With the recent widening and deepening of the Chesapeake and Delaware Canal to 35 feet, it is believed that channel dimensions will not be a constraint to the general cargo vessels and petroleum products carriers which use the Canal. However, the need for maintenance dredging in the approach channels to the Canal is a continuing problem.

The most immediate waterborne commerce related problem facing the York River is the lack of sufficient channel depth to allow large tankers to bring crude petroleum and petroleum products directly to the refinery and power plant without lightering. In 1972, the Norfolk District recommended that the York River entrance channel be improved by providing a two-lane, two-level channel into the River; the inbound lane to provide a depth of 50 feet, and the outbound lane a depth of 37 feet. However, these recommendations are subject to further investigation if the major Hampton Roads channels are recommended and authorized for deepening beyond 45 feet. It is possible that if the Hampton Roads channel is deepened beyond 50 feet, the most economically acceptable alternative is a combination of continued lightering and deepening of the York River entrance channel.

A potential problem area concerns the significant increase in crude petroleum receipts and petroleum product shipments projected for the Yorktown refinery. An increase in this type of traffic, estimated to rise almost 100 percent by 2000 and over 200 percent by 2020, means the potential for oil spills will probably also increase. The area of the York River around Yorktown supports important commercial and sport fisheries which could be adversely affected by an oil spill.

The ability of the existing channels in the remaining so-called "minor" ports and waterways on the Western Shore of the Chesapeake Bay to meet future demands depends in large measure on the proportion of the demand for petroleum products which will be met by pipeline. A basic assumption used in the preparation of the projections of waterborne petroleum movements was that all increases in the demand for petroleum products in the Bay Region would be met by waterborne, as opposed to pipeline, receipts. If pipeline capacities increase significantly, then it can be expected that the existing channels will be able to efficiently meet future demands. If they do not, then some channel deepenings may be necessary.

Another potential future problem area involves the possible location of three large petroleum refineries (Crown Petroleum in Baltimore, Hampton Roads Energy in Portsmouth, and Stewart Petroleum at Piney Point, Maryland). If all three of these facilities are built and become operational, approximately 25 million additional tons of crude petroleum and as much as 23.5 million tons of petroleum products could be shipped on the Bay's waters. An expansion in petroleum movements of this magnitude would obviously increase the chances of environmentally damaging oil spills.

Another facility designed to handle petroleum products, although of a different type, is scheduled to begin operations at Cove Point, Maryland, in the near future. This facility will distribute liquid natural gas from Algeria to a seven state area. Because of the extremely low temperatures involved, there is virtually no danger of a spill since the liquid gas would vaporize upon contact with the much warmer air. There is some potential damage, however, of a fire or explosion in the event of a collision with another vessel. Because of this, extraordinary safety procedures are taken when transporting liquid natural gas. As the total number of vessels on Chesapeake Bay increases in the future, the potential for collisions is also likely to increase.

MEANS TO SATISFY NEEDS

(1) *A need to accommodate large bulk vessels expected to dominate the world bulk trade in petroleum, coal, iron ore, and grain.* The most obvious solution to the problem of accommodating larger vessels than existing channels can handle is to deepen the channels to the required depths. There are, however, rather important economic and environmental considerations which may preclude further deepening. First, there are existing tunnels under the main channels in both Baltimore and Hampton Roads which, in effect, limit their depths since the cost of lowering these tunnels would probably be prohibitive. Second, as channel depths increase, the volume of dredge material to be disposed of from both deepening and maintenance operations increases (usually more than proportionately).

There are several alternatives to the deepening of shipping channels to accommodate larger vessels. One is to use "restricted draft" vessels which are characterized by much wider beams to allow a larger tonnage of cargo to be carried by a vessel of a given draft. However, such vessels are not presently widely available and their costs are generally higher for a given deadweight tonnage.

Another alternative to deepening existing channels is the development of so-called "superports." Under this alternative, one or more superports would be constructed in deep water off the Eastern Coast. Very large vessels, on the order of 300,000 dwt with approximately 75 foot drafts would unload at the deepwater terminal where the cargo (e.g., crude oil, coal, iron ore) would be transported to the mainland by barge or pipeline. However, this alternative is often not acceptable for economic, environmental, or social reasons.

(2) *A need for an economically and environmentally acceptable method of dredge material disposal.* Given that a channel should be maintained or deepened, there are numerous alternative ways to dispose of dredge material. The cheapest and easiest method of dredge material disposal is to deposit the material either adjacent to the channel or to barge it to a nearby deep underwater site. In the past, there were two major open water disposal sites used in the Bay–Pooles Island Deep and Kent Island. At this time, however, mainly for environmental reasons, the use of open water disposal in the Bay in the near future appears unlikely.

Open water disposal in the Atlantic Ocean is another possibility for the disposal of dredge material. The major advantage to this alternative is the almost limitless physical capacity of the ocean. This alternative has been used in the past in the Hampton Roads area, but the Baltimore area is too far from the ocean for this type of disposal to be economically feasible.

In addition, the Council on Environmental Quality has recommended to the President that ocean disposal of polluted dredge material be phased out as soon as alternatives can be found and implemented.

Another alternative method of dredge material disposal is a dyked containment structure. Both the Craney Island site, which has served the Hampton Roads dredge needs for a number of years, and the proposed Hart-Miller Islands site in Baltimore are this type of structure. These specific projects are discussed in more detail in Appendix 9. In general, dyked disposal sites are one of the least expensive forms of disposal and they can eventually support such uses as ballfields, parks, nature trails, and boat launching ramps. Local acceptdredge material disposal sites, anchorages, and even channels to avoid, whenever possible, popular boating by the construction and filling operations.

Other methods of dredged material disposal and/or utilization such as underwater sanitary landfills, "on-land" disposal at land-locked sites, beach nourishment, or the manufacture of bricks, have economic and environmental advantages and disadvantages depending on the project site, quality of the dredged material, and other variables. For the most part, however, these alternatives are best suited for smaller projects and are not solutions to long-range or large dredge material disposal problems.

(3) *A need to alleviate potential congestion problems in port, channel, and anchorage areas.* One possible solution to the potential congestion and traffic management problems was recently recommended by the Fifth Coast Guard District to the Commandant in Washington, D.C. After a two year study of the movements of commercial vessels on Chesapeake Bay, Coast Guard marine safety experts recommended implementation of a comprehensive traffic management system. The plan, which was oriented towards the Port of Baltimore and specifically to the movement of liquid natural gas into the Cove Point terminal south of Baltimore, would require the installation of government-operated communications centers at both ends of the Bay. With this network, marine traffic could be controlled in a manner similar to air traffic at a major international airport. This management responsibility has traditionally been delegated to ship pilots and captains. The Coast Guard had not yet made a final decision on the Fifth District's recommendations.

(4) *A need to minimize the potential conflicts between commercial and recreational users of the Bay's waters and beaches.* Minimizing potential conflicts between commercial and recreational uses of Chesapeake Bay can best be minimized by a careful selection of dredge material disposal sites, anchorages, and even channels to avoid, whenever possible, popular boating and sailing, fishing, swimming, and nature areas. Lightering sites, especially for petroleum, should be located where possible accidents would have the least effects on recreation areas.

(5) *A need to minimize the erosion damages from waves caused by commercial and military vessels.* As mentioned earlier, erosion caused by the wakes from ships is a serious problem in some areas. The simplest corrective action is to lower permitted vessel speeds in areas of high erosion potential, thus decreasing the eroding power of the ship-induced waves. Today's merchant ships, however, are extremely expensive to operate so that delays caused by reduced speed limits could increase shipping costs considerably, thereby offsetting any benefit to the shoreline areas affected by erosion. Another possible solution to the erosion problem would be the provision of non-structural or structural shoreline protection measures in the critically eroding areas.

(6) *A need to minimize accidental spills and eliminate deliberate discharges of wastes from commercial and recreation craft.* As discussed earlier, a comprehensive traffic management system for the Bay would reduce the potential for a collision or accident that could result in a massive spill. Appropriate Federal, State, and local controls with substantial penalties for non-compliance would probably be effective in reducing the number of occurrences. Lastly, response teams can and are being established at Federal, State, and local levels to minimize damage in the event of an accidental spill.

In response to Public Law 92-500 the provision of holding tanks or other suitable flow-through devices on all ships will be very effective in eliminating this problem. Attendant with the inclusion of ship board tanks and devices is the need for shore-based facilities that can treat the effluent pumped from ships.

(7) *A need to provide additional lands to accommodate expanding port facilities.* The present and future needs for lands to be used for port-related facilities requires that the appropriate transportation and planning agencies of State and local governments develop zoning and land use plans that will insure the orderly development of

the necessary improvements. As part of the development of the appropriate land use plans, consideration will have to be given to the impact on adjacent lands, the need for lands for competing uses such as recreation, and conflicts with natural phenomenon including hurricane flooding and shoreline erosion.

FLOOD CONTROL

CURRENT STATUS

THE TIDAL FLOODING PROBLEM

Since man first settled on the shoreline of Chesapeake Bay, he has been subject to periodic tidal flooding which has resulted in immeasurable human suffering and millions of dollars of property damage. Serious tidal flooding in the Chesapeake Bay Region is caused by either hurricanes or "northeasters." Hurricanes which reach the Middle Atlantic States are usually formed either in the Cape Verde Region or the western Caribbean Sea and move westerly and northwesterly. In most cases these storms change to a northerly and northeasterly direction in the vicinity of the East Coast of the United States.

As a hurricane progresses over the open water of the ocean, a tidal surge is built up, not only by the force of the wind and the forward movement of the storm wind field, but also by differences in atmospheric pressure accompanying the storm. The actual height reached by a hurricane tidal surge and the consequent damages incurred depend on many factors including shoreline configuration, bottom slope, difference in atmospheric pressure and wind speed. Generally the tidal surge is increased as the storm approaches land because of both the decreasing depth of the ocean and the contours of the coastline. An additional rise usually occurs when the tidal surge invades a bay or estuary and hurricane winds drive waters to higher levels in the more shallow waters. Tidal surges are greater, and the tidal flooding more severe in coastal communities which lie to the right of the storm path due to the counterclockwise spiraling of the hurricane winds and the forward movement of the storm.

TABLE 27
TIDAL ELEVATIONS DURING RECENT CHESAPEAKE BAY STORMS

Storm	Tidal Elevations (Feet Above Mean Sea Level)			
	Norfolk	Mid-Bay	Washington	Baltimore
August 1933	8.0	7.3	9.6	8.2
September 1936	7.5	–	3.0	2.3
October 1954 "Hazel"	3.3	4.8	7.3	6.0
August 1955 "Connie"	4.4	4.6	5.2	6.9
August 1955 "Diane"	4.4	4.5	5.6	5.0
April 1956 "Northeaster"	6.5	2.8	4.0	3.3
March 1962 "Northeaster"	7.4	6.0	–	4.7

TABLE 28
TIDAL FLOOD DAMAGES OF RECENT CHESAPEAKE BAY STORMS

Location	Storms and Damages in Thousands of Dollars			
	August 1933	October 1954 "Hazel"	August 1955 "Connie"	March 1962
Baltimore Metro Area	$23,500	$6,900	$11,500	Negligible
Washington Metro Area	12,000	4,800	300	Negligible
Maryland Tidewater Area	11,400	9,100	1,800	Negligible
Norfolk Metro Area	8,500	Negligible	Negligible	$ 4,800
Virginia Tidewater Area	Negligible	Negligible	Negligible	24,700

"Northeaster" is a term given to a high intensity storm which almost invariably develops near the Atlantic Coast. These storms form so rapidly that an apparently harmless weather situation may be transformed into a severe storm in as little as 6 hours. Most northeasters occur in the winter months when the temperature contrasts between the continental and maritime air masses are the greatest. The East Coast of the United States has a comparatively high incidence of this type of storm, with the area near Norfolk, Virginia, being one of the centers of highest frequency.

In the course of recorded history, the Chesapeake Bay Region has been subjected to about 100 storms that have caused damaging tidal flooding. The accounts of most of the storms that occurred prior to 1900 are very brief and are usually found only in early newspaper articles and private journals. The earliest known account of a great storm in this Area appeared in Arthur P. Middleton's *Tobacco Coast.* This storm was the great "Hurry-Cane" of August 1667 in which fields were inundated, crops were torn to shreds, houses and barns were carried away, and even the largest vessels were washed up on the beach. J. Thomas Scharf, in his *History of Baltimore City and County*, states that one of the most destructive storms of later times occurred in July 1837. The water rose twenty feet above its normal level and many sections of the city were flooded by more than five feet of water. However, the elevation and the area inundated by these early tidal floods was seldom accurately documented and it was not until the early part of the 20th century that a program to maintain continuous records of tidal elevations was initiated. The damages and loss of life suffered during these early floods is also not well documented.

Shown in Table 27 are the recorded tidal elevations at several locations for the most severe floods that have occurred in this Century. It should be noted that the relative severity of flooding varies around the Bay since it is a function of changes in storm paths and variances in climatological and astronomical tide conditions.

The hurricane of 23 August 1933 was the most destructive ever recorded. The hurricane center entered the mainland near Cape Hatteras, passed slightly west of Norfolk, Virginia, and continued in a northerly direction passing just east of Washington, D.C. It moved at or near the critical speed for producing the maximum surge, and its time of arrival coincided with the astronomical high tide as it proceeded upstream. The results were tides ranging from 8.0 feet above mean sea level (msl) at Norfolk to as high as 11.0 feet (msl) at Washington, D.C. In addition to flooding damage, the high winds associated with this storm generated very destructive waves which caused extensive shoreline erosion.

Shown in Table 28 is an estimate of the damages that were caused by the four most damaging storms that have passed through the Bay Region. The estimates reflect the actual physical damages that occurred, updated to reflect 1975 price levels. These figures do not reflect the damages that would result from a recurrence of these storms under today's conditions due to differences in intensity of development in the flood plain.

FLOOD PROBLEM AREAS

Existing flood problem areas were identified by considering the degree of tidal flooding that would be experienced by those communities located along the shoreline of the Bay and its tributaries. The analysis was limited to communities or urbanized areas since residential, commercial, and industrial development would suffer the greatest monetary losses as a result of a tidal flood.

TABLE 29
FLOODPRONE COMMUNITIES, CHESAPEAKE BAY REGION

STATE OF MARYLAND

- Anne Arundel County
  - *Arundel on the Bay
  - *Avalon Shores (Shady Side, Curtis Pt. to Horseshoe Pt. and West Shady Side)
  - Broadwater
  - Columbia Beach
  - *Deale
  - Eastport
  - Franklin Manor on the Bay and Cape Anne
  - Galesville
  - Rose Haven
- *Baltimore City
- Baltimore County
  - Back River Neck
  - *Dundalk (Including Sparrows Pt.)
  - *Middle River Neck
  - *Patapsco River Neck
- Calvert County
  - Cove Point
  - North Beach on the Bay
  - Solomons Island
- Caroline County
  - Choptank
  - *Denton
  - Federalsburg
- Cecil County
  - Elkton
  - Northeast
- Charles County
  - Cobb Island
- Dorchester County
  - *Cambridge
- Harford County
  - Havre de Grace
- Kent County
  - *Rock Hall
- Queen Anne's County
  - Dominion
  - *Grasonville
  - Stevensville
- St. Mary's County
  - Colton
  - *Piney Point
  - St. Clement Shores
  - St. George Island

STATE OF MARYLAND (Cont.)

- Somerset County
  - *Crisfield
  - *Smith Island
- Talbot County
  - Easton
  - Oxford
  - *St. Michaels
  - *Tilghman Island
- Wicomico County
  - Bivalve
  - Nanticoke
  - *Salisbury
- Worcester County
  - *Pocomoke City
  - *Snow Hill

COMMONWEALTH OF VIRGINIA

- Independent Cities
  - *Fredericksburg
  - *Hampton
  - *Norfolk
  - *Portsmouth
  - *Virginia Beach
  - *Chesapeake
- Accomack County
  - Onancock
  - Saxis
  - *Tangier Island
- King George County
  - *Dahlgren
- King William County
  - *West Point
- Northampton County
  - *Cape Charles
- Westmoreland County
  - *Colonial Beach
- York County
  - *Poquoson

*WASHINGTON, D.C.

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*Indicates "critically" floodprone communities.

The initial step in the analysis was to identify all Bay communities having a population of 1,000 or greater that are located either in total or in part within the "Standard Project Tidal Flood Plain." The Standard Project Tidal Flood (SPTF) is defined as the largest tidal flood that is likely to occur under the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographic region.

The next step in the flooding analysis was to identify those communities that should be classified as "floodprone." In order for a community to be designated as floodprone, at least 50 acres of land that were developed for intensive use had to be inundated by the SPTF. Intensive land use was defined as residential (four dwelling units/acre or greater), commercial (including institutional), or industrial development. The 59 Bay Region communities identified as floodprone are shown on Table 29. Approximately 82,000 acres of land in these communities were found to be located in the SPTF flood plain.

The last step in the flooding analysis was to further examine the communities designated as floodprone and classify each as to whether or not the tidal flood problem was considered to be "critical." The flood problem was considered to be critical if the Intermediate Regional Tidal Flood (IRTF) inundated 25 acres or more of intensively developed land and also caused significant physical damage. The IRTF is defined as that tidal flood which has a one percent chance of occurrence in any one year, generally referred to as the 100-year flood. Elevations for the 100-year tidal flood were approximated for points around Chesapeake Bay based on historical records. The flood heights used were found to range between 6.0 and 11.0 feet above msl. The communities asterisked on Table 29 are classified as "critical floodprone areas." Approximately 27,000 acres of land in these 32 communities were found to be in the 100-year tidal flood plain.

FUTURE TIDAL FLOOD PROBLEM AREAS

The criteria used for designating an area as future floodprone was that 50 acres or more of land proposed for intensive land use fall within the Standard Project Tidal Flood Plain. Areas were considered to be "critically" floodprone if 25 acres or more of land proposed for intensive land use were within the 100-year flood plain. The communities found to be critically floodprone in the future are shown on Table 30. Based on a comparison of the existing and future acreage it should be noted that an additional 58,430 acres of land is proposed for intensive development within the Standard Project Tidal Flood Plain and 19,460 acres of land within the 100-year flood plain.

TABLE 30
CRITICAL FUTURE FLOODPRONE AREAS, CHESAPEAKE BAY REGION

STATE OF MARYLAND

Anne Arundel County
Arundel on the Bay

Baltimore County
Dundalk (Including Sparrows Point)

Cecil County
Elkton
Northeast

Kent County
Rock Hall

Queen Anne's County
Grasonville
Stevensville

Somerset County
Smith Island

STATE OF MARYLAND (Cont.)

Talbot County
St. Michaels

Wicomico County
Salisbury

Worchester County
Pocomoke City

COMMONWEALTH OF VIRGINIA

Independent Cities
Hampton
Norfolk
Virginia Beach
Chesapeake

York County
Poquoson

MEANS TO SATISFY NEEDS

NON-STRUCTURAL SOLUTIONS

a. *Flood Insurance:* Until recently, insurance against flood-caused losses was virtually non-existent. Now, however, flood insurance is available in floodprone communities under the Federally-subsidized National Flood Insurance Program. A cooperative effort of the Federal Government and the private insurance industry, the program is operated by the Federal Insurance Administration of the U.S. Department of Housing and Urban Development (HUD). In return for making low cost insurance available for existing floodprone property, the program places certain obligations upon the community. The community is required to adopt and enforce land use and other control measures that will guide new development in floodprone areas so that flood damage is avoided or reduced. Most of the affected counties and local jurisdictions in the Region are enrolled in the Flood Insurance Program.

b. *Flood Proofing:* Flood proofing is actually a combination of structural changes and adjustments to properties subject to flooding. Although it is more economically applied to new construction, it is also applicable to existing facilities. Flood proofing is recommended where traditional collective types of flood protection are not feasible and where moderate flooding with low stage, low velocity, and short duration is experienced.

Flood proofing measures can be classified into three broad types. First, there are permanent measures which become an integral part of the structure. Second, there are standby measures which are used only during floods, but which are constructed or made ready prior to any flood threat. Third, there are emergency measures which are carried out during a flood according to a predetermined plan.

Permanent measures essentially involve either the elimination of openings through which water can enter or the reorganization of space within buildings. For example, unnecessary doors and windows can be permanently sealed with brick; a watertight flood shield at a doorway opening can also serve as the door; valves can be installed on basement sewer pipes to prevent flood water from backing up into the basement; or boilers, air conditioning units, and other immobile machinery can be moved to higher elevations and replaced with movable furniture or stock. Adjustments such as these can be most easily undertaken in existing buildings during periods of remodeling or expansion.

Standby measures are most desirable when it is necessary to maintain access into structures at points below selected flood protection levels. For example, display windows at commercial structures must not be blocked in order to serve their main purpose. These types of openings cannot be permanently flood proofed, but they can be fitted with removable flood shields. Since the placement and installation of such devices requires several hours, a flood warning system has to be established before such flood proofing measures can become effective.

Emergency measures are carried out during an actual flood experience. These measures may be designed to keep water out of buildings, for example, the sandbagging of entrances or the use of planking covered over with polyethylene sheeting. More often they are intended only to protect equipment and stock. A widely used emergency measure is the planned removal of contents to higher locations when a certain flood stage is reached. Again, an effective flood warning system is crucial to the effectiveness of this type of measure.

c. *Other Non-Structural Measures:* Other non-structural measures used in reducing flood damages are: permanent or temporary evacuation of the flood plain, land use controls and building codes designed to control the extent and type of future development in the flood plain, and public awareness programs to make the potential hazards of tidal flooding known to the prospective developer and/or homeowner.

STRUCTURAL SOLUTIONS

Structural solutions are defined as those man-made structures that are designed to protect an area from tidal flood damages. Floodwalls and levees are two examples of these types of structures. While differing in design, appearance, and cost, floodwalls and levees serve essentially the same purpose. Both are constructed near the shoreline to protect landside development from inundation by tidal floodwaters. Floodwalls are generally concrete and may have vertical, curved or stepped faces. Levees are usually earth embankments having a top width of approximately 10 feet and side slopes that vary between 1 on 2 and 1 on 4. Levees are generally less expensive than floodwalls and are particularly applicable in areas where construction materials are nearby and there is sufficient area between the shoreline and the development for their construction. Floodwalls may be used where the close proximity of the development to the shoreline precludes the construction of levees.

Because of the high cost of providing this type of protection, the applicability of levees and floodwalls in the Bay Region would generally be limited to those highly developed urbanized areas where there is extensive residential, commercial, or industrial development that is subject to damaging flooding. It should also be noted that providing a levee or floodwall of sufficient height to protect against a major tidal flood could severely restrict the use of the shoreline for recreational or transportation and shipping purposes. Also, the protection may be considered unacceptable from an aesthetic standpoint if the view of the water body is restricted.

A breakwater is another type of flood protection structure. It is designed to break the force of storm waves and thus reduce the damage that would be experienced by storm waves breaking on shoreline development. Breakwaters are also used to create harbors of refuge that provide safe mooring for recreational and commercial craft. Breakwaters may be either shore connected or located offshore and are generally classified by either the construction materials or the method of construction. Different types of breakwaters may be constructed of stone or concrete blocks (rubble-mound breakwaters), stone-asphalt mixtures, reinforced concrete shells filled wtih stone or sand, steel sheet piling cells filled with sand, timber cribs filled with rubble, or mobile or floating breakwaters which may be moved into place when a tidal flood is predicted. The most common type of breakwater in the Chesapeake Bay Region is the shore connected, rubble-mound breakwater. In the sheltered waters of the Bay and the sub-estuaries this type of protection is very effective and usually can be constructed with materials that are available locally.

Recreational and commercial craft are particularly susceptible to damage caused by the large waves associated with tidal flooding. Harbors of refuge provide areas of calm water for the safe mooring of all types of craft. Harbors of refuge can be naturally sheltered areas such as coves or inlets or existing marinas, and mooring areas protected through the use of breakwaters as discussed above.

Other structural measures including bulkheads, revetments, groins, and beach nourishment that are used primarily for shoreline erosion control also have some applicability as flood control measures. A detailed description of these measures is included in Appendix 11 – Shoreline Erosion.

SHORELINE EROSION

CURRENT STATUS

THE SHORELINE EROSION PROCESS

The shorelands of Chesapeake Bay are composed of three physiographic elements–fastland, shore, and nearshore (Figure 29). The fastland is that area landward of normal water levels. The shore is the zone of beaches and wetlands which serve as a buffer between the water body and the fastland. Lastly, the nearshore extends waterward from the mean low water level to the 12-foot depth contour. In the Chesapeake Bay proper, the nearshore is generally comprised of a shallow water belt more than 1,000 feet wide before the 6-foot mean low water depth contour is encountered. From the 6-foot contour outward, the depth increases at a more rapid rate.

While the causes of shoreline erosion are complex and not completely understood, the primary processes responsible for erosion are wave action, tidal currents, and groundwater activity. Waves generated by wind are the cause of most of the shoreline erosion in the Bay Region. The amount of wave energy which reaches the shoreline is dependent on the slope of the nearshore. A shallow nearshore will dissipate more wave energy than a deep nearshore. In addition, less wave energy is received by a shoreline if there is a shoal, tidal flat, or aquatic vegetaion immediately offshore. Similarly, a wide beach is better than a narrow beach for wave dissipation. Conversely, where the shoreline has none of the above natural features and wave action is strong, undercutting of the ground landward of the beach will cause sliding, slumping, and resultant loss of fastland.

Waves associated with hurricanes or other large storms can be extremely damaging. These storms can generate very large, steep wind waves which can remove considerable material from the shore zone and carry it offshore. Strong winds of these storms often raise water levels and expose to wave attack lands of higher elevation that are not ordinarily vulnerable.

Erosion problems caused by tidal currents are usually most severe in constricted areas such as inlets to lagoons and bays or at entrances to harbors. In addition to creating currents which cause erosion, the tides constantly change the level at which waves attack the beach, thereby aggravating the problem.

Another process which contributes to the erosion of the shoreline is the seepage of groundwater through the fastland and into the exposed shore zone. As shown on Figure 30, taken from the Chester River Study prepared by the State of Maryland and the Westinghouse Electric Corporation, water percolates downward through porous soils and flows out through exposed bank faces often causing an erosion of bank materials. This process is accelerated where man has removed the natural cover on the land adjacent to the banks thus increasing the amount of rainfall seeping into the ground.

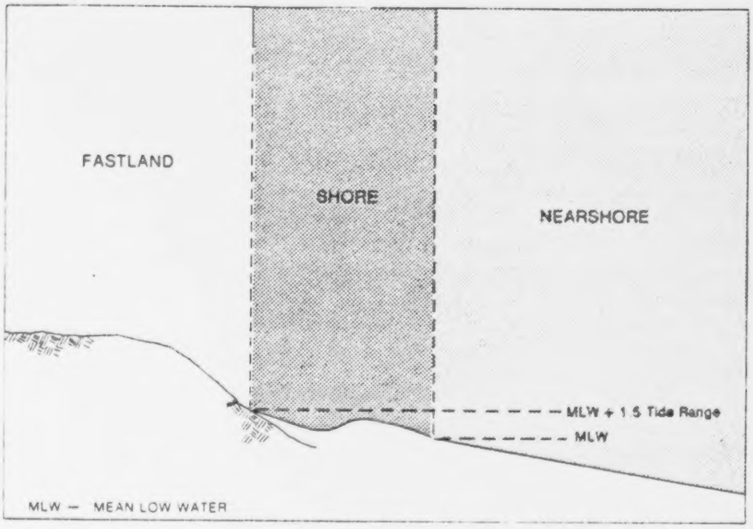

Figure 29: Shorelands of Chesapeake Bay

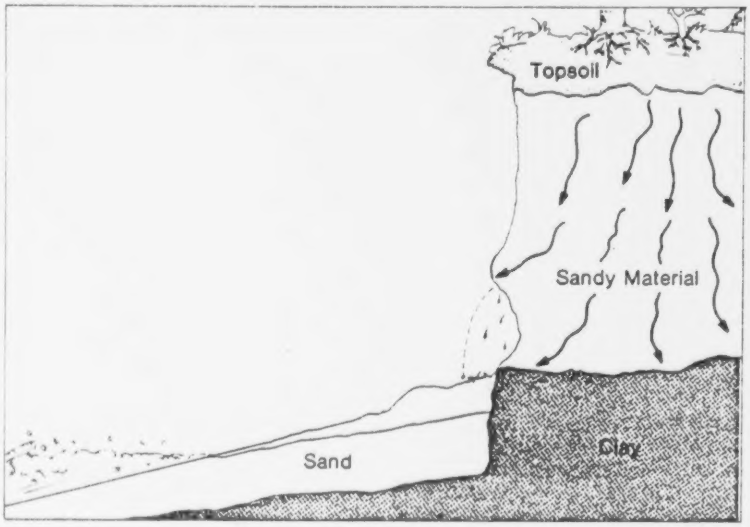

Figure 30: Shoreline Erosion Caused by the Seepage of Groundwater

To a much lesser degree, three other factors contribute to the shoreline erosion problem in Chesapeake Bay. First, the long term rise of sea level has resulted in the inundation or loss of land to the Bay. An average rise of 0.01 feet per year has been recorded in the lower Chesapeake Bay. At Fort McHenry in Baltimore, Maryland, the National Ocean Survey tide gage indicated a 0.6 foot rise in mean sea level between 1902 and 1962. These seemingly insignificant rates of increase can over the years inundate significant land area particularly where shorelands have very gentle slopes. Second, rainfall runoff can cause or contribute significantly to shoreline erosion, particularly in areas where the adjacent shoreline is rolling and broken and soils are made up of easily erodible materials. Last, in some areas of the Bay, especially around busy harbors and waterways such as the Chesapeake and Delaware Canal, the wakes from passing ships are a significant erosive force.

EXISTING PROBLEMS AND CONFLICTS

The natural processes discussed in the preceding paragraphs have claimed thousands of acres of land around Chesapeake Bay and its tributaries. Over the last 100 years alone, approximately 45,000 acres of land have been lost due to tidal erosion. The configuration of the shoreline has changed markedly in some areas; and certain islands, some of which exceeded 400 acres in size, have ceased to exist.

The most significant impact of the loss of this amount of land has been on the landowners who have witnessed the loss of both valuable shoreland and improvements that may have been constructed too close to the shoreline. Attempts to try to arrest the rate of erosion through either poorly designed or constructed protective measures have further frustrated property owners when their efforts proved futile. In many cases, man has accelerated the rate of erosion by eliminating natural protective devices such as vegetative cover that inhibit erosion.

Sediment, the product of erosion, has also had significant impacts on both the natural environment and man's use of the resource. Sediment from shoreline erosion may eventually be deposited in either natural or man-made navigation channels requiring maintenance dredging and the problems normally associated with the disposal of the dredged material. In addition, sediment also has a considerable impact on water quality and the biota of the Bay. Sediment can cover productive oyster beds and valuable aquatic plants. The reduced light penetration into turbid waters can also be very detrimental to aquatic life.

In order to define those areas or reaches of tidal shoreline along the Bay and its tributaries that are suffering "critical" losses of land, an inventory of historical erosion rates and the adjacent land use was compiled. The erosion rates used in the compilation were developed by the Maryland Geological Survey and the Virginia Institute of Marine Sciences for the Maryland and Virginia portions of the Bay, respectively.

In the determination of the shoreline erosion rates the shoreline was broken down into workable lengths called "reaches," which range from several hundred to several thousand feet in length. These reaches were established based on physiographic characteristics including the erosion or deposition rate. The inventory of the erosion rates on a reach by reach basis for each tidal county in Maryland and Virginia is included in Tables A-1 and A-2, respectively, of Appendix 11—Shoreline Erosion.

Using these erosion rates along with land use information developed by the U.S. Geological Survey as part of the CARETS program, reaches were designated as having critical erosion problems if they met or exceeded the following criteria:

1. The erosion rate was equal to or greater than 3 feet per year regardless of adjacent land use.

2. The erosion rate was equal to or greater than 2 feet per year and the adjacent land use was intensive, i.e., residential, commercial, or industrial.

TABLE 31
LENGTH OF CRITICALLY ERODING SHORELINE
STATE OF MARYLAND

County/City	Length of Critical Shoreline Miles
Anne Arundel	32.4
Baltimore	5.0
Calvert	9.6
Cecil	9.3
Charles	8.2
Dorchester	61.6
Harford	5.7
Kent	9.9
Queen Anne's	24.0
Somerset	23.0
St. Mary's	20.6
Talbot	27.1
Wicomico	23.1
TOTAL	259.5

TABLE 32
LENGTH OF CRITICALLY ERODING SHORELINE
COMMONWEALTH OF VIRGINIA

County/City	Length of Critical Shoreline Miles
Accomack	24.2
Essex	7.6
Gloucester	7.0
Hampton	14.2
Isle of Wight	7.7
Lancaster	8.4
Mathews	9.7
Middlesex	7.7
Northampton	10.4
Northumberland	18.3
Richmond	3.5
Surry	3.8
Virginia Beach	6.0
Westmoreland	10.4
York	4.0
TOTAL	142.9

Using the above criteria and assumptions, approximately 403 miles of shoreline were identified as existing "critical erosion reaches." Table 11-1 of Appendix 11 lists each critical reach by county and state, the land use in the reach, reach length, erosion rate and an evaluation of existing structural shoreline protection measures within the reach. Plates 11-1 through 11-3 in Appendix 11 show the location of these critical reaches. Tables 31 and 32 in this Summary list the amount of critically eroding shoreline by county for Maryland and Virginia.

TABLE 33
FUTURE CRITICALLY ERODING REACHES
(MARYLAND)

LOCALITY
WATER BODY/
REACH DESIGNATION

Anne Arundel County

- Chesapeake Bay
  - Bodkin Point
  - Persimmon Point

Calvert County

- Chesapeake Bay
  - From approximately ½ mile north of Plum Point to Parker Creek
  - From approximately ½ mile north of Flag Ponds to Cove Point
  - Cape Anne

Cecil County

- Northeast River
  - Charlestown to Carpenter Point
  - Northeast Heights to Red Point

Kent County

- Chesapeake Bay
  - 2 miles south of Tolchester Beach to Tavern Creek

Queen Anne's County

- Chesapeake Bay
  - Broad Creek to ¾ mile south of Carney Creek
- Chesapeake Bay
  - Jackson Creek to Piney Cove
- Eastern Bay
  - Greenwood to Bennett Point

Wicomico County

- Nanticoke River
  - Roaring Point
- Bivalve Harbor to 1 mile north

FUTURE SHORELINE EROSION PROBLEMS

The method employed to delineate future problem areas is essentially the same as that used to define the existing critical areas. It was assumed that the historical erosion rates were reflective of future erosion rates in the same reaches. It was further assumed that future land use adjacent to the shoreline would develop as shown in the latest regional, county, or municipal land use planning documents. Given the historical erosion rates and projected future land use adjacent to the shoreline, the entire Bay shoreline was surveyed to determine if any future development was proposed in areas subjected to significant shoreline erosion.

It was determined that an additional 44.4 miles of Bay shoreline has the potential to become a serious problem. (See Tables 33 and 34). This is in addition to the over 400 miles of shoreline that is currently classified as critical based on existing development.

NON-STRUCTURAL SOLUTIONS

Nonstructural solutions consist of devices which enhance the effectiveness of natural protective features and regulatory actions that can be employed to avoid a land use-erosion conflict. The following nonstructural measures have applicability in shoreline erosion problems in Chesapeake Bay.

a. *Marsh Creation.* As previously mentioned, marshes tend to buffer the shoreline against wave action and its consequential erosive forces. Under certain conditions, marshes can be created by selective placement of material in the nearshore zone and the seeding and transplanting of native plants such as saltmarsh cordgrass *(Spartina Alterniflora)*. A possible source of material for the creation of marshes is dredged material from channel maintenance and deepening projects. The use of this material would not only serve to provide erosion control and create additional fish and wildlife habitat, but it could help solve the problem of finding acceptable disposal sites for dredged material.

b. *Vegetative Cover.* In addition to improving the ability of the shoreline and fastland areas to resist erosion, vegetation can trap windblown material and thus aid in the formation of a protective dune. Vegetation as a sole protection against erosion has proven to be unsuccessful except in well-protected areas. Its widest application has been its use in conjunction with other structural measures such as bulkheads and groins. It has also been used to stabilize backfills of bulkheads and in combination with groins in the creation and stabilization of beaches.

TABLE 34
FUTURE CRITICALLY ERODING REACHES
(VIRGINIA)

LOCALITY	WATER BODY/	REACH DESIGNATION
Gloucester County		
	Ware River	Ware River Point to Old House Creek
	Mobjack Bay	Ware River Point to Turtleneck Point
	York River	Sandy Point to east of Perrin River
City of Hampton		
	Back River	Harris Creek to North End Point
Lancaster County		
	Rappahannock River	Wyatt Creek to Greenvale Creek
		Navy Auxiliary Air Force to Mulberry Creek
		Mulberry Creek to Curletts Point
	Corrotoman River	Eastern Shoreline
Northumberland County		
	Potomac River	Eastern Shoreline of Wilkens Creek
	Chesapeake Bay	Taskmers Creek to Warehouse Creek
Richmond County		
	Rappahannock River	Morattico Creek to Tarpley Point
		Tarpley Point to Sharps Road Point
		Sharps Road Point to Rechardson Creek
		Waverly Point to McGuire Creek
Westmoreland County		
	Potomac River	Ragged Point to Jackson Creek
York County		
	York River	Skiming Creek to 1.8 mile south

c. *Regulatory Actions and Public Awareness Programs.* Land use regulations can be used to set aside critically eroding reaches for such non-intensive uses as recreation or open space. This action would prohibit development of structures that would be threatened by a rapidly receding shoreline.

A second approach is to adopt building codes which would allow for development in eroding areas but that would require the construction of the appropriate erosion control measures. The developer would be required to provide continuous protection for the length of the reach.

A public awareness program could be used to advise the public as to the location and severity of shoreline erosion and could also provide information as to the structural and nonstructural measures that could be used to control erosion.

STRUCTURAL SOLUTIONS

Structural solutions are defined as those man-made structures that are designed to either prevent waves and tidal action from reaching erodible material or that retard the longshore transport of littoral drift (i.e., the movement of sediments parallel to the shore in the nearshore zone by waves and currents) and thus aid the build-up of the natural nearshore defenses. Bulkheads and revetments are the most commonly used structures that prevent erosive forces from reaching the fastland while groins and beach nourishment are most frequently employed in the Region to build up the nearshore. The following paragraphs include a general discussion of the above mentioned structural measures and their general design characteristics.

a. *Bulkheads.* The main purpose of a bulkhead is to retain the earth behind it, to deflect the energy of incoming waves, and to prevent flooding. Bulkheads which are essentially vertical walls, can be constructed of wood, stone, concrete, or metals, but are commonly made of wood, with a framework of pilings and cross-timbers called wales covered with a sheathing of thick boards nailed or bolted to the framework. Areas around Chesapeake Bay where such protection can be most effectively used are in sheltered waters such as coves, harbors, and in small bays. In open waters, such as on the Bay proper, bulkheads may be relatively ineffective as the severity of the water action causes scouring at the bottom of the structure and eventually undermines the bulkhead itself.

b. *Revetments.* A revetment consists of armoring the sloping face of the shore with one or more layers of riprap or concrete. The sloping characteristic in this design serves to dissipate wave energy as the water rolls up the incline. Riprap is composed of stone, chunks of concrete, rubble or brick and it is the most common type of revetment construction employed in the Bay Area. The irregular surface of riprap also serves to break up water momentum and provide niches which capture sediment and thus adds stability. Gabions consisting of riprap enclosed in wire mesh cages may also be used. These baskets capture sediment and grow protective vegetation which eventually blends the structure into the surroundings. Properly designed revetments can effectively retard erosion even in severe cases. In certain ineffective attempts to halt erosion, unsuitable materials such as junked car bodies, engines, and tires have been used as riprap to absorb wave energy.

c. *Groins.* A groin is a barrier-type structure which extends perpendicular to the shoreline into the nearshore zone of sand movement. The basic purpose of a groin is to interrupt alongshore sand movement in order to accumulate sand on the shore or to retard sand losses. Some groins or groin fields interrupt the flow of sand to downdrift areas thus causing damage to these shorelines. In order to minimize damage to the shoreline downstream from a groin, it has to be designed with the top profile not higher than that of a beach of reasonable dimensions. When full, a groin of this type will permit the stream of sand to pass over its top and continue on downstream to nourish the neighboring shores. Groins should not be built unless properly designed for the particular site and the effects of the groins on adjacent beaches have been adequately studied by an engineer experienced in this field.

d. *Beach Nourishment.* Another measure which can be used either singularly or in connection with the previously mentioned measures is beach nourishment. Beach nourishment is the addition of sand from another source to an eroding natural beach thereby replacing the material lost to erosion and extending the natural protection provided by the nearshore. To restore an eroded beach and stabilize it at the restored position, material is placed directly along the eroded sector and additional material is stockpiled at the updrift end of the problem area. The stockpiled material will then maintain the restored portion of the beach. When conditions are suitable for artificial nourishment, long reaches of shore may be protected by this method at a relatively low cost per linear foot of shoreline.

SECTION IV

FISH AND WILDLIFE

The fish and wildlife of the Chesapeake Bay Area contribute in many ways to making the Bay what it is today, both in terms of commercial markets and in terms of recreational enjoyment. Increasingly, people are turning to the out-of-doors for use of their leisure time, and fish and wildlife contribute both directly and indirectly to the value of the outdoor experience. Sport hunting and fishing,. for example, are major activities of outdoor enthusiasts, as are such activities as birdwatching and nature photography. In addition, commercial interests rely on fish and wildlife resources as a source of income and employment. The future requirements for fish and wildlife for commercial and recreational uses are the subject of this section. The strictly biological value of fish and wildlife as part of the Bay ecosystem is discussed in Chapter II.

CURRENT STATUS

COMMERCIAL FISHERIES

A commercial fishery is a business that involves catching, or "harvesting," a particular finfish or shellfish, deliverance of the product to the wholesale market, and subsequently "processing" the product for the retail trade. "Harvesting" and "processing" are the terms used to describe the two particular sectors of the commercial fishing industry.

In the harvesting sector, average commercial landings during the period 1966 to 1970 totaled 381 million pounds worth nearly $30 million. About 82 percent of this total harvest of finfish and shellfish was landed in areas located on Chesapeake Bay proper, as shown in Table 35, with the balance being landed in tributaries to the Bay. Finfish consist of both edible and industrial species. The latter include mainly menhaden and alewives, which together averaged 243 million pounds worth $3.7 million between 1966 and 1970. Menhaden alone accounted for 90 percent of all finfish landings by weight in 1970. Edible finfish types include striped bass, weakfish, shad, catfish, bluefish, and white perch, among others.

Shellfish, which are commonly harvested commercially, include crabs, oysters, and soft clams. Based on data presented in Table 35, shellfish harvests between 1966 and 1970 averaged 88 million pounds (excludes shell weight of clams and oysters) worth $23 million . The fact that shellfish represent the big money crop in Chesapeake Bay is illustrated in Figure 31 which compares finfish with shellfish in terms of both landings weight and value. Shellfish comprise only 24 of the total commercial harvest by weight, but a substantial 78 percent of the total value.

The most recent data available on commercial harvests of finfish and shellfish in Chesapeake Bay are for 1973. During the year, commercial landings of bluefish exceeded all previous records at 2.8 million pounds as did landings of the gray sea trout which were 4.4 million pounds. This is a 93 percent increase in poundage for the latter species and a 134 percent increase in value over 1972. Landings of croaker were up 188 percent after being very scarce the previous 6 years. In contrast, landings of alewives in 1973 were nearly half of the 1970 catch and commercial catches of yellow and white perch were also down markedly from 1970 levels.

Commercial shellfish harvests in 1973 were of comparable magnitude to harvests of 1966-1970, in terms of both weight and value. Of interest, however, is the fact that oysters were harvested in Maryland waters in quantities unexceeded since 1937, despite the impacts of Tropical Storm Agnes in 1972, and that harvests in Virginia were the *lowest* on record. This apparent discrepancy can be explained by the fact that oysters in Maryland experienced good reproductive years in 1969 and 1970 which resulted in oysters of sufficient size to survive the large freshwater influx due to Agnes. Oysters in the State did not have a good reproductive year during the 1971-1976 period, however, and this is expected to affect future landings. Factors affecting the Virginia oysters include a disease which invaded the Commonwealth's oyster beds in the early 1960's; poor reproductive years prior to 1973; and the effects of Agnes. The clam landings, and to a lesser extent crab catches, in both States were down considerably from previous years due to a large extent to the effects of Tropical Storm Agnes.

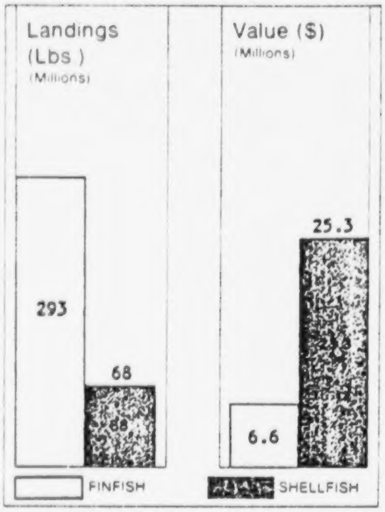

Figure 31: Average Finfish and Shellfish Harvest, 1966-1970, Chesapeake Bay Region.

Employment in the harvesting and processing sectors is also an important component of the commercial fishing industry. The most recent data from 1973 show employment in the commercial harvesting sector to be about 17,400 full-time and part-time fishermen operating nearly 12,000 vessels of various sizes. The number of fishermen in the Chesapeake Bay Region has stayed relatively constant since 1954, fluctuating between a low of 16,800 in 1962 to a high of 20,200 in 1955. The number of vessels has also stayed fairly constant during this period.

In addition, in Maryland and Virginia, about 7,100 persons were employed in the processing sector in wholesale and processing plants in 1973. Since fresh seafood is highly perishable, much of the Chesapeake Bay catch is processed and wholesaled in close proximity to where the landings are made. Average annual employment in the Chesapeake Bay seafood wholesaling and processing industries has been characterized by modest gains since the early 1950's. The number of establishments has declined steadily, however, since the late 1950's when the average number of establishments in the Region was 704.

TABLE 35
COMMERCIAL FISHERY HARVEST
AVERAGE 1966-1970 (1)
CHESAPEAKE BAY AND TRIBUTARIES
(IN THOUSANDS)

Water Area	Acres	Finfish				Shellfish		Total	
		Edible		Industrial					
		Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Chesapeake Bay (2)	2,041	24,177	1,443	234,976	3,590	54,244	8,166	313,397	13,199
Chester River	35	436	54	6	Negl.	2,012	889	2,454	943
Choptank River	69	880	118	7	Negl.	4,800	1,730	5,687	1,848
Nanticoke River	18	506	67	24	1	537	236	1,067	304
Patuxent River	30	260	39	5	Negl.	896	500	1,161	539
Wicomico River	10	96	11	9	Negl.	143	93	248	104
Potomac River	310	11,006	590	3,974	73	10,543	4,673	25,523	5,336
Rappahannock River	98	4,898	219	1,993	35	7,498	2,005	14,389	2,259
York River	55	2,513	113	1,577	30	3,856	572	7,946	715
James River	166	4,695	264	1,125	20	3,834	4,398	9,654	4,682
TOTAL STUDY AREA	2,832	49,467	2,918	243,696	3,749	88,363	23,262	381,526	29,929

(1) This table was based on preliminary unpublished data developed in 1972.

(2) Bay proper exclusive of tributaries.

This fact reflects the National trend in recent decades toward larger establishments of higher employment. Most of the seafood processing and wholesaling establishments in the Chesapeake Bay Region were located in the Northern Neck area of Virginia (i.e., the tidewater portion of Virginia between the Potomac and Rappahannock Rivers) and on the middle and lower portions of the Maryland and Virginia Eastern Shore.

COMMERCIAL FURBEARERS

A significant economic resource of the Bay Region, but one that is often overlooked, is the furbearing mammals of the wetland and terrestrial habitats found within the Study Area. Furbearing species commonly trapped in the Study Area are beaver, gray fox, red fox, mink, muskrat, opossum, otter, raccoon, skunk, weasel, and bobcat. The muskrat is of primary economic importance since it provides approximately 69 percent of the total income of Bay trappers. The fur harvest for the 1971-72 season in Maryland and Virginia was valued at approximately $1.8 million, including the meat value of certain of the species (especially muskrat). Although specific data are not available, a major portion of the total bi-state fur harvest is felt by experts to derive from the Bay Region. In addition, it should be noted that the value of the harvest represents money paid trappers and does not represent economic activity generated in the processing and retailing sectors of the industry.

SPORT FISHING AND HUNTING

Increases in income, population, and available leisure time have stimulated increases in sport fishing and hunting in the Chesapeake Bay Area. Recreational fishing accounts for a significant portion of the total landings for several species of fish within the Study Area, including, in order of pounds landed in 1970: spot, striped bass, white perch, weakfish, shad, croaker, flounder, yellow perch, catfish, and bluefish. All of these but striped bass, flounder, and catfish actually exceeded the commercial catch, demonstrating the importance of recreational fishing in the Bay. Shellfish are also taken by a considerable number of people on a recreational basis. It has been estimated that blue crabs are sought by as many people as are game fish, and that the recreational quantity caught may equal the whole commercial harvest. Definitive statistics on recreational harvests of shellfish are not available.

Hunting is also an important form of recreation within the Study Area. Upland forests, farm lands, wetlands and open water are utilized as a source of food or shelter for various species of game animals. The upland forest and farm land provide habitat for deer, rabbit, squirrel, woodchuck, raccoon, and opossum as well as game birds such as turkey, quail, dove, woodcock, and others. More closely associated with the Bay are the many species which depend on the wetlands and open water for their habitat requirements. The most significant of these are the numerous species of waterfowl which winter in the Bay area and provide many man-days of hunting experience for outdoor enthusiasts, as well as significant economic benefit to the Region. Expenditures for licenses, hunting land leases, food, lodging, gasoline, club memberships, and equipment are estimated to amount to $300 to $500 annually per waterfowl hunter. The estimated annual value of waterfowl hunting in the State of Maryland is 10.5 to 17.5 million dollars.

NON-CONSUMPTIVE UTILIZATION OF RESOURCES

The wetland and upland habitat as well as the waters of the Bay and its tributaries provide habitats which support an extensive variety of flora and fauna. These organisms provide a source of recreation to large numbers of people who enjoy birdwatching, nature walking and nature photography. Research indicates that the number of people in the U.S. in 1970 that participated in these non-consumptive outdoor activities was about 9 percent higher than the number of people fishing and hunting. Aside from the enjoyment which is gained from an association with the natural resources of the area, the Bay, its tributaries, associated wetlands, and upland areas provide valuable educational services as classrooms for natural science studies.

EXISTING PROBLEMS AND CONFLICTS

With growth of the population and development of the economy in the Bay Area, conflicts have arisen between the need for more intensive use of the existing land and water resources and the need for these same resources to maintain fish and wildlife populations. This is especially true in the wetland areas where dredge-and-fill operations have been performed to develop industrial and agricultural lands, and to provide for second home development, and marinas.

Water quality problems, which have also become more pronounced with increased economic development and population growth, have serious implications for fish and wildlife. Almost every activity of man in the Chesapeake Bay Area produces a waste product that often is most conveniently dumped in a nearby river or stream. These tributaries invariably flow to the Bay. Problems that result are as varied as the constituents themselves. With the many new substances being developed each year, the task of assessing the effects on the environment of the resulting effluents and the possible interrelationships between constituent and other variables, such as temperature and salinity, may already be impossible.

Conflicts and problems also arise within the internal workings of the various elements of the fish and wildlife management structure. This is because management of the wildlife, fisheries, and shellfish resources of the Chesapeake Bay and its tributaries is the responsibility of several organizations including the Federal Government, the States of Maryland, Delaware, and Virginia, and the Potomac River Fisheries Commission. The inconsistencies in laws promulgated by these organizations create conflicts in the management practices and utilization of the resource. In the case of migratory birds, for example, the basic regulations regarding bag limits and the number of days a species may be hunted during a season are set by Federal regulation. However, the actual dates for the opening of a season are determined by the States under guidelines set forth by the Federal regulations. The hunters of a state having a later opening date, therefore, often feel that they will have a decreased chance for success since the species sought has been previously hunted in a neighboring state and may be "gun shy." Crabbing regulations are another example of this type of problem. Virginia allows the dredging of wintering crabs which are buried in the Bay bottom while Maryland forbids this activity. Many Marylanders feel that this dredging depletes the supply of crabs which would be available to them the following season. Also, the management and regulation of anadromous fish catches in the Lower Chesapeake Bay obviously affects the fishery in the Upper Bay. For example, concentrated offshore fishing efforts for herring (under the jurisdiction of the Federal Government) have greatly reduced the spawning runs of this species in the Bay each spring.

Fluctuations that occur in finfish and shellfish populations are another problem to be considered. Historically, the populations of many species have varied cyclically over periods of years, due to complex biological factors such as predator-prey relationships; physical and chemical factors such as changes in salinities due to long term drought or rainy periods; or man-caused factors such as pollution or level of exploitation of the resource. These causative factors are far from being understood, much less controlled. Fluctuations in Maryland blue crab populations, as indicated by landings, are a classic example of this "boom" or "bust" phenomenon. For example, in the State of Maryland between 1953 and 1957 the catch went from 28 million bushels down to 16 million and then back up to slightly less than 32 million bushels. The all-time record low harvest for Maryland of 10 million bushels in 1968 was followed in 1969 by a respectable 25 million bushels (the all-time record high for the State was 37 million bushels). There are at least two major factors in explaining the volatility of the blue crab population. First, its short life span of two to three years creates a high "turnover" of crabs. Second, the crabs caught in Maryland are transported as larva and tiny crabs from their spawning grounds in Virginia into the upper Estuary. The condition of the upper Estuary when the young crabs arrive and the physical, chemical, and biological stresses they must endure during their journey are critical to the Maryland harvest the following years. It is interesting to note that in 1968 when the Maryland catch dropped by nearly two-thirds, the Virginia catch was off by only about one-fifth.

The striped bass population in Chesapeake Bay also follows distinct cycles. There are several factors suspected of producing a "dominant-year class" including some little understood biological mechanism which triggers a larger than normal hatch when the adult population has declined below a certain level. This phenomenon has also been observed in other species.

Some researchers believe that the number of rockfish (striped bass) in the Bay is inversely related to the bluefish population since the more aggressive bluefish compete for the same food supply and even prey on the young striped bass. As the blue crab and striped bass examples indicate, often drastic fluctuations in species populations are a natural phenomenon. However, since the reasons for this phenomenon are not completely understood, it is extremely difficult to separate the natural fluctuations from fluctuations caused by man-related factors such as excess nutrients, thermal effluents, sedimentation, or other pollutants.

FUTURE FISH AND WILDLIFE NEEDS

FINFISH AND SHELLFISH

Needs for fish and shellfish resources were obtained through comparison of future demand with available supply. Functions of future demand involved such parameters as market price, projections of commercial and recreational catch, and costs of the harvesting effort. Population dynamics for each species were based, in part, on estimates of maximum sustainable yields (MSY's). MSY's are defined as the greatest harvest which can be taken from a population without affecting subsequent harvests.

Typical supply versus demand curves are shown in Figure 32 to illustrate the relationship between MSY, supply, demand, and commodity price. The term "supply" refers only to the amount commercially harvested. Excess demand is shown for the years 2000 and 2020 where the demand curves do not intersect the supply curve. In these cases, sufficient supplies cannot be had at any price since the MSY has been exceeded. Sustained harvesting beyond the MSY results in eventual decline in the species population due to overharvesting. As total harvest of a species approaches MSY, it was assumed that recreational catches will have precedence over those in the commercial sector. As a result, commercial catches of many recreationally important species are actually projected to decline over the projection period.

TABLE 36
PROJECTED PERIOD OF EXCEEDENCE OF MAXIMUM SUSTAINABLE YIELD (MSY) FOR THE MAJOR COMMERCIAL AND SPORTS SPECIES

	Base Year Catches*		Period of MSY Exceedence		
Species	1,000 lbs	Percent MSY	Prior to 1980	1980-2000	2000-2020
Blue Crab	61,373	94		X	
Oysters	23,740	79			X
Softshell Clams	5,412	90			X
Menhaden	449,790	90			X
Alewife	21,110	84			X
Spot	14,193	96	X		
Striped Bass	11,159	96		X	
White Perch	7,225	64		X	
Shad	7,120	93		X	
Weakfish (Sea Trout)	5,174	81		X	
Flounder	4,575	89		X	
Catfish	2,440	54	(will not be exceeded before 2020)		
Scup	2,281	35	(will not be exceeded before 2020)		
Sea Bass	2,084	42	(will not be exceeded before 2020)		
American Eel	1,692	99			
Yellow Perch	1,511	44	(will not be exceeded before 2020)		

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* Represents commercial plus recreational catch except for blue crabs, oysters, and soft clams.

Results of the analysis, conducted as described above for each species, are shown in Table 36. All of the commercially and recreationally important species, with four exceptions, are projected to experience commercial and recreational pressures which will exceed their MSY's at some time during the projection period. MSY is expected to be exceeded for half of the species by the year 2000. Of this latter group, with the exception of the blue crab and American eel, projected increases in recreational catches are the major reason for the early exceedence of MSY. Oysters, soft clams, menhaden, and alewife are primarily commercial species which explains, at least in part, the later period for MSY exceedence. Catfish, scup, sea bass, and yellow perch populations are capable of withstanding significant increases in fishing intensity, without adverse effect. All four species are underutilized commercially for a number of social and economic reasons.

It should be noted that as commercial and recreational demands increase relative to the capacity of the fisheries, the market system responds by increasing prices. For example, the prices, after adjustment for inflation, of blue crabs, oysters, and striped bass are expected to increase by 525 percent, 194 percent, and 967 percent, respectively, between 1970 and 2020. The upward pressure on prices is especially acute due to the basic assumption used in the analysis that as catches approach MSY, recreational utilization of these finfish and shellfish species will take precedence over commercial uses.

THE HARVESTING AND PROCESSING SECTORS

Future needs in the harvesting and

processing sectors of the commercial fisheries industry will be affected by the projections of future market price and demand presented in the previous section. The decrease in commercial landings indicated for a majority of the finfish species for which projections were made was interpreted as revealing a contraction in the finfish segment of the *harvesting* sector. While increases in commercial landings of some finfish species were revealed, most notably yellow perch, catfish, sea bass, and alewife, these are not considered to be large enough to offset the employment losses in the declining fisheries.

Of the projections made for the three shellfish species, the predicted increases in oyster landings was the only result considered to be significant to the harvesting sector. The predicted landing increases, however, cannot be interpreted as implying a need for expansion of employment in the oyster harvesting industry. Of critical importance is the present capacity of the oyster fishery and the degree to which it is utilized. Currently, in Maryland, for example, each licensed oysterman is limited to a catch of 25 bushels per day. Assuming two persons per rig, the catch limit would be 50 bushels. Experience has indicated that various rigs are capable of harvesting two or three times this quantity. In light of this, it was concluded that the present capacity of the harvesting sector of the oyster industry would be sufficient to meet future demands.

The future of the processing sector was found to be a function of the projections for alewife, menhaden, oyster, blue crabs, and clams. Since commercial catches of these species are generally expected to increase or remain fairly constant over the projection period, the projections of yield appear, at a minimum, to be capable of supporting a processing sector of current size and degree of utilization.

WILDLIFE

Future needs for wildlife in the Chesapeake Bay Area were determined in terms of recreation days of hunter participation for small game, big game, and waterfowl. Hunting demands were based on license price, population, and expected hunter participation rates. For big game, since hunter effort in this category has historically been insensitive to license price, projections were made a function of population only. The projected demands for small game and waterfowl hunting were made based on the assumption that license prices will increase in the future.

As shown in Figure 33, waterfowl hunting, perhaps economically the most important type of hunting effort in the Bay Region, is projected to increase by 70 percent during the projection period. Big game hunting is projected to increase at the highest rate of any of the three types of hunting effort in the Bay Region (141 percent) and by 2020 is expected to be the most popular type of hunting in the Region. Small game hunting demand is projected to decline over the projection period.

The amount of land available for the use of hunters as well as the amount of habitat for the game animals were the critical factors in determining supply. It was not deemed practical to project the numbers of individuals within a given species available for hunting purposes. The increase in the amount of land needed to satisfy future hunting needs was assumed to be proportional to the increase in hunting effort. Based on this, land access requirements will increase by 7, 35, and 61 percent, by 1980, 2000, and 2020, respectively, over the amount available in 1970.

Factors affecting the accessibility of land to hunters, and the maintenance and health of game populations include:

1) conversion of farm and woodlands to urban and suburban land uses;

2) reluctance of land owners to open private lands to recreationists;

3) single-purpose leasing of agricultural and other lands for hunting;

4) impact of large-scale modern farming on reduction of habitat;

5) single species tree farming practices which decrease wildlife use;

6) use of herbicides for weed control which eliminates small game habitat.

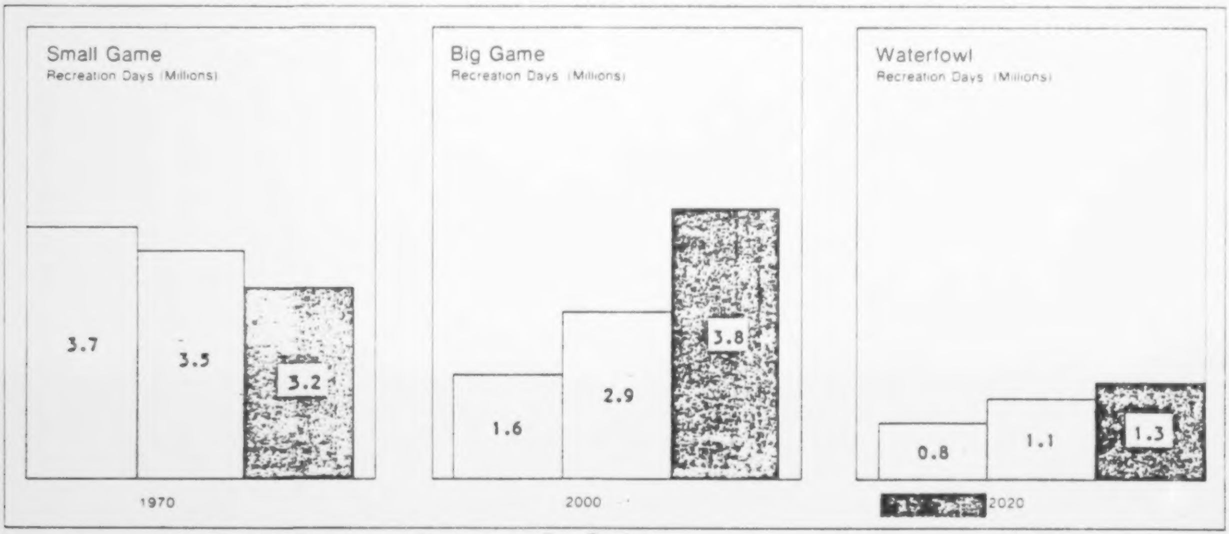

Figure 33: Projected Hunter Effort in the Chesapeake Bay Region

NON-CONSUMPTIVE WILDLIFE

Future needs for wildlife to support such non-consumptive uses as bird watching, wildlife photography, and just plain enjoyment of nature, are expected to increase with future population and increases in leisure time. As shown in Figure 34, non-consumptive wildlife utilization in terms of recreation days in the Chesapeake Bay Area (excluding nature walking) is projected to increase at a slightly higher rate than the population. Nature walking is expected to increase at a rate equal to population growth. A total increase of 34.6 million recreation days is projected to occur by the year 2020.

As in the hunting analysis, the factors most affecting the provision of a quality non-consumptive recreational experience are the availability of suitable habitats for wildlife and the provision of public access. At the present time the amount of land and wildlife habitat which is available to the non-consumptive resource user in the Study Area includes about 814,000 acres of public, semi-public and park lands. An additional 11.5 million acres of privately owned agricultural lands, woodlands and wetlands are located in the Bay, an unknown quantity of which is accessible to the public. Assuming a constant percentage of the resources users will continue to use the non-public areas, future projections can be made regarding the acreage of public lands required to provide non-consumptive resources users with an experience of equal quality to the present recreational experience. These projections are shown in Table 37.

TABLE 37
PUBLIC LAND REQUIRED TO
MEET FUTURE NON-CONSUMPTIVE
RECREATIONAL DEMAND

Year	Number of Rec Days	Acres of Public Land
1970	18,130,000	814,000
1980	21,448,000	964,000
2000	30,871,000	1,387,000
2020	41,078,000	1,845,000

The most significant problem facing the provision of land for non-consumptive wildlife purposes is the inevitable conflicts with other land uses in a developing area such as the Chesapeake Bay Region. For the bird watcher, wildlife photographer, and nature walker, a quality experience relies upon a variety and abundance of wildlife in a natural uncrowded setting. Because of expected increases in population and development pressures, there is a threat of degradation in many areas. For example, the development of lands adjacent to recreational areas may cause overutilization, noise, and the disappearance of seclusive species, all of which reduce the desirability of the area.

MEANS TO SATISFY THE NEEDS

SHELLFISH

Demands for oysters, blue crabs, and softshell clams are projected to exceed MSY by the end of the projection period. The supply of oysters can, and presently is, being supplemented by the management and cultivation of the species by both State and private interests. More intensive effort in this regard would help to satisfy the expected demands over the projection period. The cultivation of softshell clams, while not presently practiced, is a possible means of meeting excess demands for this species. The possibility also exists that other species may be harvested to fulfill some of the demand for softshell clams. The substitution could derive from an increased harvest of hard clams (which unfortunately are already over harvested in some areas), or more likely from utilization of a species such as the brackish water clam *(Rangia cuneata)*, which at present is not sought commercially.

The cost of culture practices for blue crabs would probably be prohibitive due to fluctuations in the natural supply and market price. This variability would keep the culture of the species from being profitable on a regular basis. Thus, if the need is to be satisfied, it will probably be by increasing the blue crab harvest in other areas such as South Carolina or Louisiana and importing into the Bay Region.

INDUSTRIAL FINFISH

The demand for both menhaden and alewife, the major industrial species in Chesapeake Bay, is projected to exceed the MSY by 2020. Since artificial cultivation of most estuarine finfish species is either uneconomical or impractical, substitute species or products will have to be found in order to fulfill the needs for the products derived from these species. For example, soy beans are currently

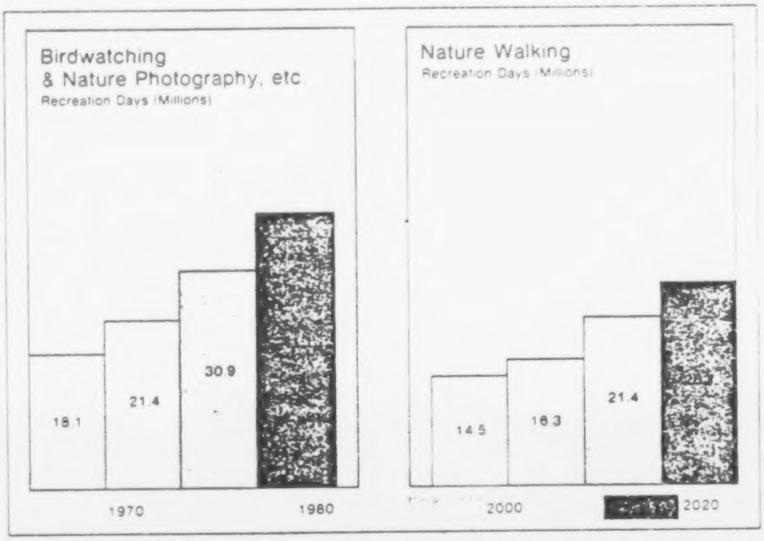

Figure 34: Projected Non-Consumptive Wildlife-Related Outdoor Activity in the Chesapeake Bay Region

being processed to produce many products which can be substituted for menhaden and alewife. Agriculture cannot, however, be considered as the ultimate solution to meeting these demands since the production capabilities of these lands are finite and they must also be used to meet the demands for other products.

NON-INDUSTRIAL FINFISH

Edible species commonly sought by sport and commercial fishermen in the Bay include white perch, striped bass, shad, flounder, spot, weakfish, eel, yellow perch, sea bass, scup, and catfish. Of these eleven species only the last four are projected to have supplies that will meet the demands through the year 2020 as shown earlier in Table 36. When considering the means to satisfy the needs for these species, a first alternative might be a management program to insure increased production of these species by improving habitat, or by controlling the harvest of individual species based on population surveys.

If management practices are to be effectively implemented on a Bay-wide basis, records of the sport fishing utilization are necessary. One method of providing this information and at the same time providing funds for the initiation of management and research programs would be through the sale of salt water fishing licenses. Although this proposal has been suggested and rejected previously, it is still a viable method for gaining the data and knowledge necessary to insure continuance of a quality fishery in the Bay.

The harvest of under-utilized species has provided an interim solution to the fulfillment of the needs for fisheries products on previous occasions and could be an aid in the fulfillment of the needs for overall production in the future. Care should be taken, however, to provide management practices to protect the under-utilized species from depletion once a market is opened. Such exploitation has occurred with the surf clam. Because of a lack of restrictions and an available market, vast areas of once productive surf clam beds have been rapidly depleted.

WILDLIFE

The lack of information concerning factors that influence the population of many wildlife species, and possible future changes in human utilization of these species hinders an accurate determination of future needs. Due to this, any consideration of the means to satisfy the needs must, of necessity, be in generalized terms. Because the projections indicate greatly increased demands for wildlife resources, the means to be discussed in this section will include methods for increasing supply and availability.

As implied previously, the problem of maintaining an adequate supply of wildlife to meet all our projected needs must be considered on two levels—the primary level being the requirements that must be met in order for wildlife to sustain viable populations; the secondary level being a problem of providing access to the wildlife for human use. As is the case with public acquisition of key wildlife habitat, the solution to these two problems may coincide.

Other than the actual hunting of the animals, wildlife populations are impacted by two major areas of man's activities. These are land use and pollution, with land use probably the most significant.

If the land use problem is to be resolved, a firm commitment on the part of the public and responsible public officials will be required to conserve existing desirable wildlife habitat, reclaim certain lands to support desired wildlife types, acquire additional public lands, and discourage land use practices which are unnecessarily destructive of wildlife habitat. These measures would help insure stabilization and enhancement of wildlife populations. Strict zoning will be required to regulate land use. Coupled with zoning, purchasing mechanisms such as bond issues should be developed to buy those lands considered especially important to wildlife. If purchase is not desirable, then long-term leasing arrangements offer an alternative, in conjunction with tax incentives to affected land owners.

Pollution, a by-product of civilization, also has a significant effect on wildlife populations. A prime example of the adverse impact of pollution on wildlife is the absence of many species of fish-eating furbearers along stretches of water that are polluted. Other examples include the impact of chlorinated hydrocarbons on the reproductive success of fish-eating carnivorous birds such as the osprey and bald eagle, and the as yet unknown effects of trace metal consumption by certain species of waterfowl and shore and wading birds. Oil pollution can also cause a serious adverse impact on aquatic oriented bird populations. In the Bay Region, thousands of bird deaths have resulted from oil spills. The solution to this type of problem lies with careful and thorough enforcement of existing pollution control laws and with the vigorous pursuit of new technology to control and abate pollution sources.

Other than the need for viable wildlife populations themselves, is the need for increased land access to the resource. Purchase of additional lands particularly valuable to wildlife certainly offers a partial solution to meeting these needs. Land purchase, of course, should not be considered a complete answer to land access shortages. Combined with purchase of lands especially valuable to wildlife, a program of wildlife access leases could also be instituted. Such leases could be an adjunct to the wildlife management leases previously proposed. The purpose of the combined wildlife management and access lease would be to provide large areas where wildlife habitat can be actively managed and where access by the wildlife viewer and hunter would be allowed on a managed basis. A fee for all wildlife users could be charged to supply funding for the program. Success of such a program would depend to a large extent on cooperation between the wildlife utilization groups, the involved state agencies, and the individual land owners.

There are undoubtedly numerous other approaches to the problems. A key realization that must underlie any successful solution is that the threat to fish and wildlife is not the sole responsibility of the sport and commercial fisherman nor the hunter or commercial trapper. The real threats to these

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resources are adverse land and water uses and an apathetic attitude on the part of the public toward preserving fish and wildlife habitat. If these factors can be incorporated into a comprehensive conservation, enhancement, and preservation program directed toward maintaining quality habitat, then an effective program can be developed to balance human utilization with the productive capability of the resource. Until such programs are in effect the resource manager will be faced with a continuously dwindling resource base and a concurrent and continuous increase in resource needs.

ELECTRIC POWER

CURRENT STATUS

POWER REQUIREMENTS AND GENERATING FACILITIES

In studying the electric power resources of Chesapeake Bay, a geographic area encompassing the electric utilities serving the Bay Region was defined. This area, the Chesapeake Bay Market Area, is delineated in Figure 35.

The total number of utilities serving the Chesapeake Market Area is 74. The utilities are of varied ownerships: private corporations, municipalities, consumer cooperatives, and the Federal government. Investor-owned utilities provide 90 percent of the energy requirements for the Market and are responsible for 95 percent of the electricity generated. They also operate virtually all of the transmission facilities. The municipally-owned utilities are small and derive most or all of their energy from the large investor-owned utilities with only minimal generation of their own. The cooperatively-owned utilities for the most part purchase all their energy from other utilities. Where they do have generating capacity, it is in small plants with relatively little output. There is only one Federal utility in the Market Area, the Kerr and Philpott Project. This project, operated by the U.S. Army Corps of Engineers, produces wholesale energy for many of the cooperatives in Chesapeake South and other utilities outside the Market Area.

The utilities within the Chesapeake Market Area operate as bulk power suppliers, wholesale generators, or wholesale purchasers. The bulk power suppliers operate substantially all of the generating and transmission facilities in the Chesapeake Market. They, besides furnishing their own franchise requirements, sell large amounts of energy to other utilities, mainly municipals and cooperatives.

Wholesale generators operate a generating plant and sometimes associated transmission lines and sell the entire output to other utilities under long-term contracts. There are two such utilities in the Market Area, the Kerr and Philpott Project and Susquehanna Electric Company; both operate hydroelectic plants.

Wholesale purchasers are the most numerous of the utilities in the Chesapeake Market. They buy energy at bulk rates from bulk power suppliers or wholesale generators and resell it to their own retail customers. In several instances the purchased energy is supplemented by a minor amount of self-generation. They are of municipal, investor, or cooperative ownership.

MARKET SECTORS

In recognition of the geographical and technical characteristics of the Market Area utilities, the Market was divided into three Sectors: Chesapeake West, Chesapeake East, and Chesapeake South. As shown in Figure 35, Chesapeake West includes the Baltimore-Washington corridor of the Pennsylvania-New Jersey-Maryland power interconnection (PJM Pool); Chesapeake East takes in the Delmarva Peninsula portion of the PJM Pool; and Chesapeake South covers the Virginia portion of the Virginia-North Carolina-South Carolina power interconnection (VACAR Pool). Figure 36 shows the relative energy requirements in each market sector as of 1972. A brief description of each sector follows.

a. *Chesapeake West.* There are three utilities which serve the Chesapeake West sector: the Potomac Electric Power Company, Baltimore Gas and Electric Company, and the Southern Maryland Electric Cooperative. The energy requirements of Chesapeake West in 1972 were 28,252 gigawatthours while the amount of energy generated was 32,311 gigawatthours. Almost all of this excess energy was delivered to more northerly members of the PJM pool outside the Chesapeake Bay Market with only minor amounts flowing into Chesapeake South. The generating facilities are all in investor-owned utilities with 86 percent of the total generation accounted for by fossil steam plants and the remainder by combustion plants. Southern Maryland Electric Cooperative purchases its entire needs from the Potomac Electric Power Company. It is the largest cooperative in the Market Area with energy requirements in 1972 of 676 gigawatthours.

b. *Chesapeake East.* Chesapeake East has 24 utilities: 8 investor-owned, 13 municipally-owned, and 3 cooperatives. The largest investor-owned utility, Delmarva Power and Light Company, supplies more than half of the Sector's energy requirements and accounts for about 2/3 of its generation. The energy used in this Sector in 1972 was 7,370 gigawatthours while 8,876 gigawatthours was generated. Approximately 65 percent of the energy was generated in fossil steam plants, 11 percent in combustion facilities, and 24 percent in a single hydroelectric plant at Conowingo on the Susquehanna River in Maryland. The bulk of the excess generation came from the hydroelectric plant and was delivered to the more northernly parts of the PJM Pool beyond the Market boundaries. Easton Municipal, the Market Area's only isolated utility, is located in Chesapeake East. Easton's entire energy requirements of 75 gigawatthours in 1972 were furnished by this combustion plant.

c. *Chesapeake South.* Three investor-owned utilities, 23 municipals, 20 cooperatives, and one Federally-operated project serve Chesapeake South. The energy requirement of this Sector in 1972 was 29,474 gigawatthours while 26,414 gigawatthours were generated. There was a modest net import of electricity, almost entirely from outside the Chesapeake Bay Market Area. Virginia

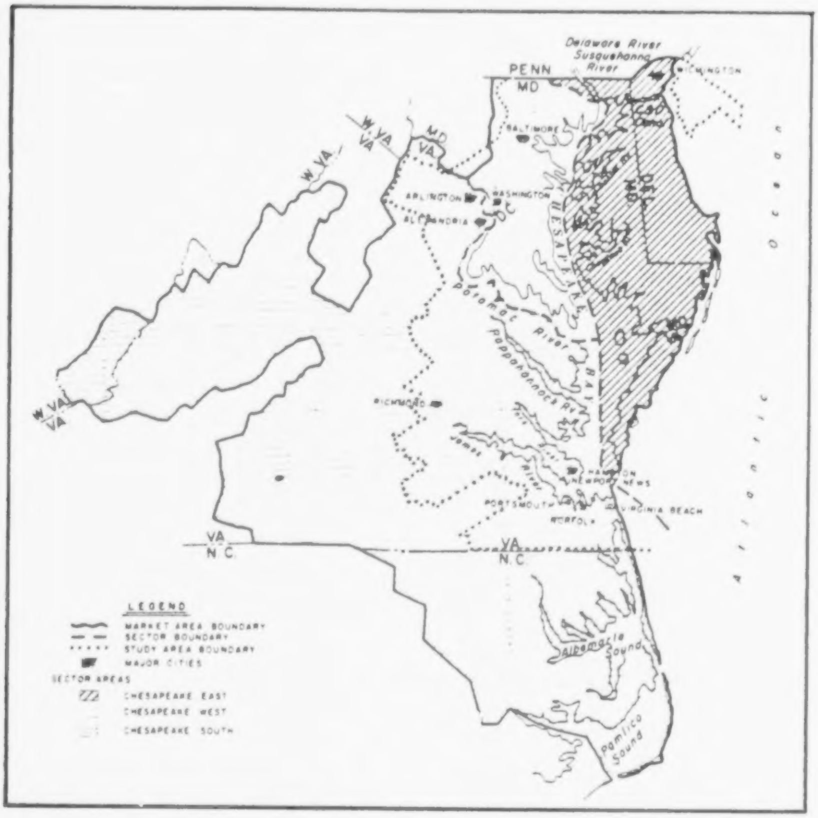

Figure 35: Chesapeake Bay Market Sector and Study Area

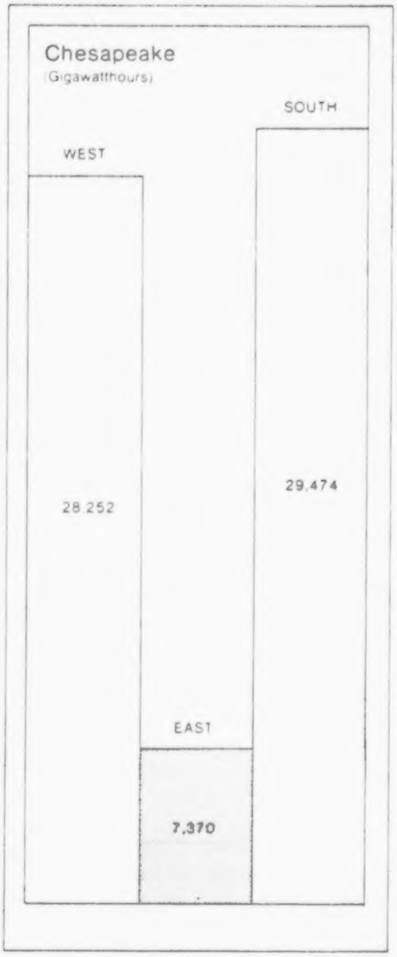

Figure 36: Total Energy Requirements of Chesapeake Bay Market Sectors, 1972

Electric and Power Company accounting for about 90% of both energy and generation is the major utility in Chesapeake South. The only other significant generation in the Sector is at the Kerr and Philpott Project of the Corps of Engineers. This project produced 698 gigawatthours from its two hydroelectric plants, which was delivered at wholesale rates to cooperatives in the Sector and certain utilities beyond the Market boundaries. Fossil fuel steam plants accounted for 70 percent of total generating capacity, nuclear steam for 13 percent, combustion plants for 9 percent, and hydro facilities for 8 percent.

Figure 37 shows the "energy account" for the Chesapeake Bay Market Area in 1972. This energy account is a flowchart showing the source and disposition of energy for each of the three Sectors. For example, in Chesapeake East, 8,876 gigawatthours of electricity were generated during the year–6,429 by fossil fuel plants, 2,243 by hydroelectric plants and 204 by combustion plants. Of the total generation of 8,876 gigawatthours, 2,426 were sold to customers outside the Chesapeake Bay Market Area. On the other hand, utilities in the Chesapeake East Sector bought 847 gigawatthours of electricity from utilities outside the Market Area. In addition, 73 gigawatthours of electricity were bought from industrial and commercial concerns in the Market Area which operate generating plants for their own internal use. The 7,370 gigawatthours figure represents the total energy requirements of the Chesapeake East Sector–the net sum of total generation, receipts, and deliveries. Similar, more detailed energy accounts are presented for each Sector in Appendix 13–"Electric Power."

EXISTING POWER FACILITIES

As shown on Table 38, approximately 91 percent of the electric power produced in the Market Area was generated by fossil steam generation plants using coal, oil, or gas as fuels. Oil was the most frequently used type of fossil fuel in 1972. The remainder of the electricity was produced by hydropower, nuclear or combustion facilities. The only nuclear plant in operation at the time in the Market Area (located at Surry, Virginia) operated at less than full capacity during 1972. In 1973, the first year of full service for the plant, approximately 6,900 gigawatthours of electricity were produced. Another nuclear plant of similar capacity began operations in May, 1975 at Calvert Cliffs, Maryland. Shown in Figure 38 are the power plants which were located in the Chesapeake Bay Market Area in 1972. In addition to the power plants themselves, many miles of major transmission lines are required in order for a modern utility to efficiently serve its customers. The Chesapeake Bay Market Area has approximately 2,672

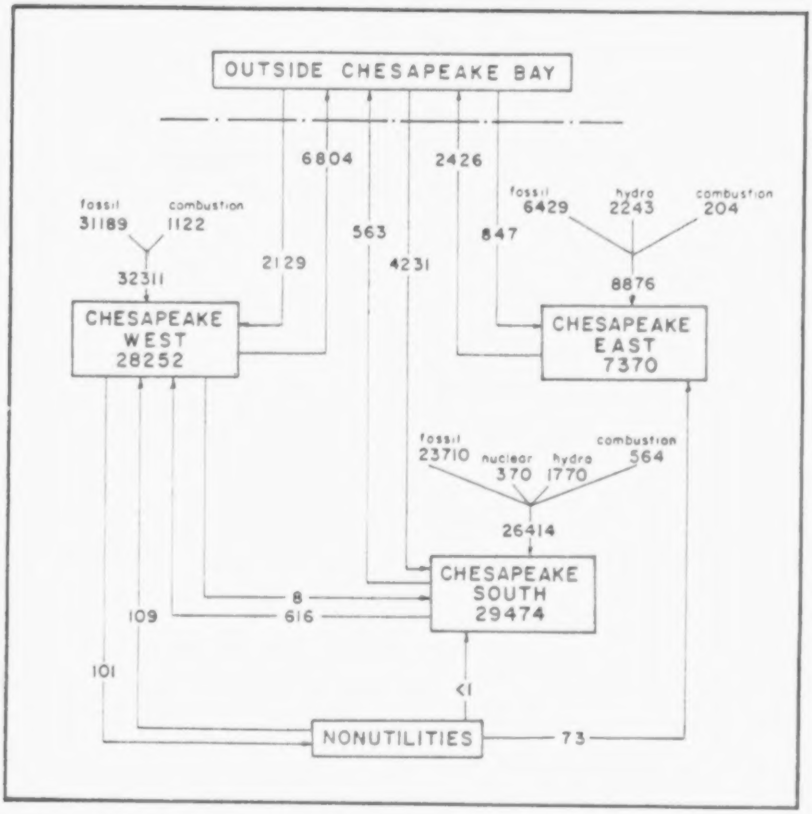

Figure 37: Energy Account for Chesapeake Bay Market Area, 1972

miles of 230 to 500 kilovolt (KV) transmission lines. These size lines are supported by steel towers. In addition, 131 miles of 138 KV transmission lines, usually supported by wood frames although steel poles and towers are occasionally used, are located in the Market Area. These transmission lines have obvious adverse visual impacts on the environment and when the amount of right-of-way required is considered, they consume a surprisingly large amount of land. In 1972, the amount of land used by transmission lines and right-of-ways amounted to approximately 54,000 acres.

COOLING WATER REQUIREMENTS

The production of electricity by the steam cycle involves the condensation of exhaust steam back to water and the consequent release of waste heat. Nearly all existing steam-electric plants use cooling water in the process of removing the waste heat from the power generating system. The heated cooling water, having accomplished its task is returned to its source, in this case, usually Chesapeake Bay or one of its tributaries.

All but three of the steam plants in the Chesapeake Market employ "once-through" cooling (i.e., as opposed to re-cycled cooling waters). The rate of flow of the cooling water through the plant and the rise in cooling water temperature differ among plants because of variations in design and operating conditions of the facility. There is only a slight consumptive use of water in the once-through system due to the small evaporative losses caused by the increased temperature of the cooling water discharge. In general, the temperature rise of cooling water in the plant is usually in the range of 10°F to 25°F (6°C to 14°C). Maximum allowable temperature increases are established by Federal and State regulations. Large nuclear steam-electric plants, however, require approximately 50 percent more cooling water for a given temperature rise than a fossil plant of equal size. This has a great deal of significance since, as shown in the next section, nuclear plants are projected to supply a much larger portion of the Region's energy requirements in the future. Where adequate supplies of natural water are available, the once-through cooling system is usually adopted because it is the most economical method of cooling.

Where natural bodies of water of adequate size are not available at the site, or are excluded from use by water quality standards, cooling ponds or towers may be constructed. The only cooling pond installation contemplated for the Chesapeake Bay Study Area is at the North Anna plant on the North Anna River in Virginia which is presently under construction. Where cooling towers are used, the heated water is cooled for reuse by a stream of flowing air. The air flow is usually a natural draft rising through the tower which is contoured to create the necessary circulatory conditions. Such natural draft towers are huge structures, about 300 feet in diameter at the base and some 450 feet tall. Each tower provides cooling for a generating plant of about 500 to 1,000 megawatts.

TABLE 38
PERCENT CONTRIBUTION OF FUEL TYPES
TO TOTAL ELECTRIC GENERATION – 1972

Sector	Fossil Steam Generation			Hydropower	Nuclear	Combustion
	Coal	Oil	Gas			
Chesapeake East	29	42	2	25	–	2
Chesapeake West	48	48	–	–	–	4
Chesapeake South	26	64	–	7	1	2
TOTAL MARKET AREA	36	54	<1	6	<1	3

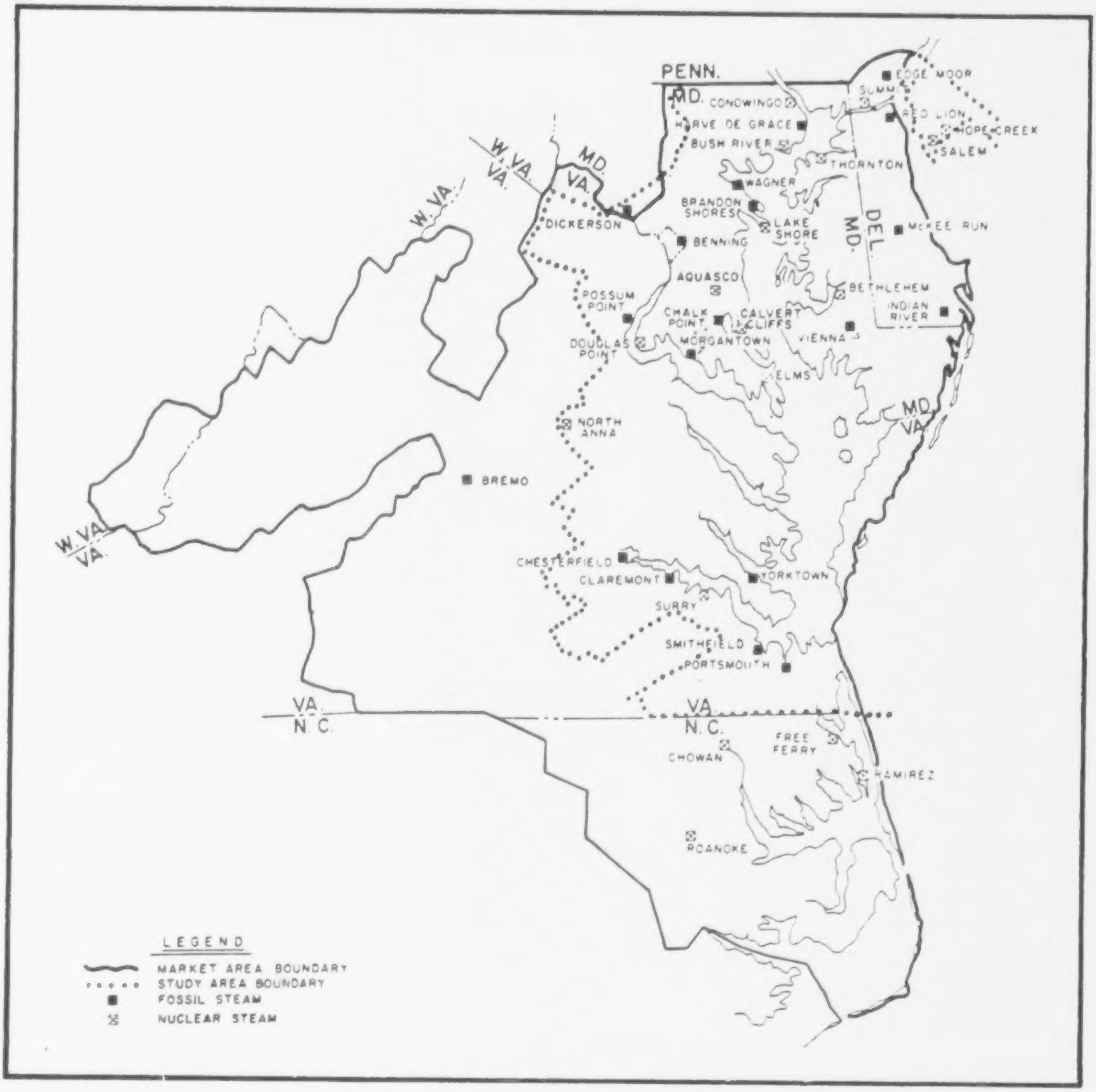

Figure 38: Chesapeake Bay Power Plant Location Map, 1972

In the "wet cooling tower" the warm water is sprayed into the stream of flowing air. This facilitates the heat dissipation by evaporation as air moves through the tower. The cooled water is collected in a basin under the tower from which it can be pumped back to the plant for reuse. The water which is lost through evaporation is replaced by withdrawals from a local natural water body. Currently, there is only one natural draft wet cooling tower in operation in the Chesapeake Bay Market Area. This plant is located at Chalk Point, Maryland, and has been in operation since 1975. However, many cooling towers of this type are included in the plans for facilities scheduled to be constructed in the future.

EXISTING PROBLEMS AND CONFLICTS

In addition to the conflicts of use which may arise in the Study Area as a result of multiple demands for water or land, the resolution of certain social issues currently affecting the utility industry could also influence use of water and land for the generation of electric power in the Study Area.

Prevailing controversies concerning the generation of electric power and its impact on the environment include such issues as esthetics, air pollution, water quality, impingement and entrainment of fish, radiological effects, and the disposal of nuclear wastes.

Steam generating plants are expansive installations that can present a relatively unsightly overall appearance and hydroelectric plants can often intrude on scenic areas. Both entail competitive use of water and may preclude other esthetic developments. Concealment of transmission towers and transmission lines is sometimes difficult; they cannot always be placed out of view or effectively blended into the surroundings.

The types and quantities of emissions from the combustion of fossil fuels in the production of electric power created a demand for air pollution control as a major siting criteria in planning future plants. The necessity for large quantities of cooling water introduces problems of fish impingement, entrapment, and entrainment. The effects of releasing this water in a heated condition and its impact on aquatic life are other issues of controversy. Environmental regulations currently prescribe the use of a closed cycle cooling system for generating units to be installed in 1985 and thereafter. The resulting reduction of heat input to the cooling water source is offset by an approximately twofold increase in evaporative water consumption. The varied impacts of the thermal and consumption effects may exchange an apparent current problem for a potential future problem.

During their operation nuclear power plants are permitted to release, under well controlled and carefully monitored conditions, low levels of radioactivity. Current technologies for the treatment and storage of radioactive wastes are characterized as currently adequate. The adequacy of these technologies however, are controversial.

With increasing emphasis on environmental protection, the utility industry, in cooperation with the Federal Government, some state governments, and some research institutes, have ongoing programs which are attempting to find ways to minimize the environmental impact of electric power generation and still maintain a reasonable cost for electric power.

The public, government, and the electric industry in general are all currently enmeshed in a reassessment and reevaluation of the generation of electric power by nuclear fission. The public inquiry with regard to safety and long-term justification of a nuclear program and the economic impact of double-digit inflation on the cost of nuclear power has introduced some question regarding the future of nuclear power generation. Final resolution of these issues could influence the utilization of nuclear capacity throughout the country and in the Market Area. The Chesapeake Bay Market utilities presently plan the installation of considerable nuclear capacity but still anticipate substantial additions of fossil generation. Because of the lower thermal efficiencies of nuclear units, increasing nuclear capacity increases water use about 50 percent for each nuclear unit which replaces a comparably-sized fossil unit. Land use for plant siting is reduced because large fuel storage and handling areas, needed for coal or oil, are not required for nuclear fuel, but transmission rights-of-way could require more land because of the need to site nuclear facilities further from the population centers. Opportunities for joint use of the land would also tend to be less because of the remote locations, but such settings might be attractive for recreational development.

Should future events constrain the installation of additional nuclear capacity base load requirements would have to be met with generation by coal or oil. In this regard, conflicts between the national energy and environmental interests and between these interests and the economic vitality of the electric utilities are currently evident and resolution of these conflicts could have varied impacts on the water and land requirements.

The goal of national energy independence favors the consumption of coal while environmental laws often preclude the combustion of certain types of coal in power plants without adequate environmental equipment. The resultant economic penalty, in addition to uncertainties of supply and regulatory postures pertaining to coal combustion, tends to discourage the use of coal. Coal-fired plants need relatively large land areas for coal storage, handling, and ash disposal. Fuel storage and handling and ash disposal in oil-fired plants involve less land area but would likely involve more waterfront land area to accommodate waterborne oil transport. The use of imported oil would be undesirable from both energy independence and national security postures.

FUTURE ELECTRIC POWER NEEDS, SUPPLIES, AND PROBLEMS

PROJECTED DEMANDS

In general, the projections of demand in this analysis were developed by extrapolating various historical trends and subjectively modifying those trends to reflect judgements regarding factors currently in force and which could plausibly continue into the future. The projections chosen reflect a belief that growth in the use of electric power will continue but at a somewhat reduced rate. This approach

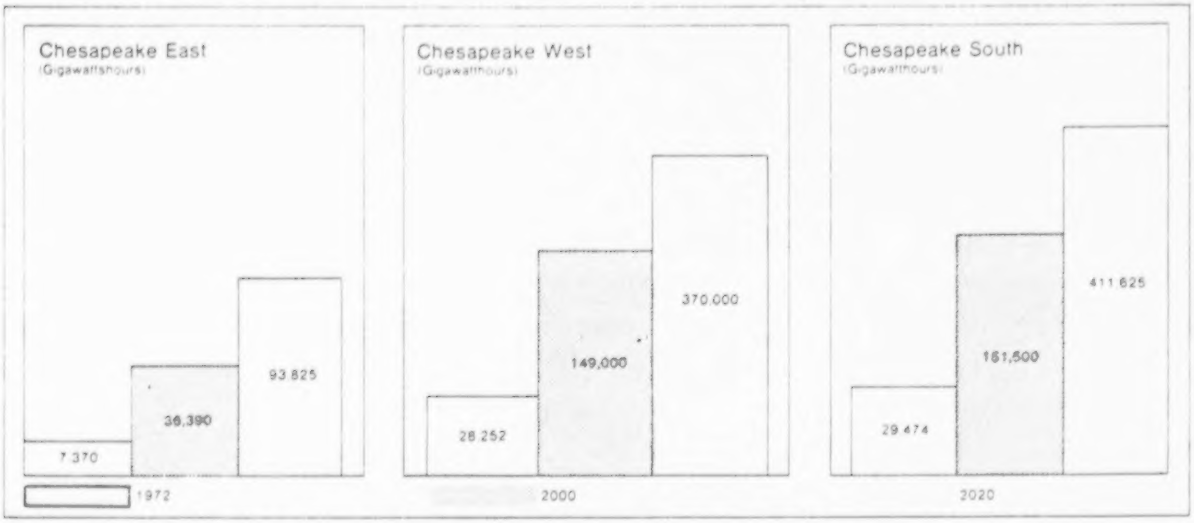

Figure 39: Projected Energy Requirements Including Peak Demand for Chesapeake Bay Market Areas

is believed to be moderately conservative with regard to the potential for energy conservation but recognizes the significant role electric power will continue to play in the National economy.

Even with "conservative" growth rates, the total use of electricity in the Chesapeake Bay Market Area is expected to increase by a factor of over 5 times by the year 2000 and approximately 13.5 times by the end of the projection period. As shown in Figure 39, the Chesapeake South Sector which includes the major metropolitan areas of Norfolk-Portsmouth, Hampton-Newport News, Richmond, and the Virginia suburbs of Washington, D.C. is expected to experience the highest rate of increase. While the rate of growth for the other Sectors are lower than those of Chesapeake South, the rates still reflect significant increases in electricity requirements for these sectors by the year 2020.

SUPPLY METHODOLOGY

The power supply facilities projected through 1985 are either in service, under construction or in the advanced design stage. Accordingly, the projected supply picture through this period reflects the generation already planned by utilities in the Market Area at this writing.

For the years after 1985 the supply program utilized current and expected trends in the relative proportions of steam generation to total generation and of nuclear generation to fossil. The capacity projected assumes all units projected for meeting Market Area loads after 1985 are located within the Market Area.

With regard to future water consumption and withdrawal rates by power plants, once-through cooling is prohibited, under the present EPA regulations, on all plants scheduled for service in 1985 and thereafter. Plants scheduled before 1985 employing the once-through system may retain them throughout the remainder of their useful lives. For this Study, it is assumed that all projected capacity on line after 1985 will employ the wet towers cooling method.

PROJECTED SUPPLY AND PLANT LOCATION

It is projected that by the year 1985, approximately 44 percent of the Market Area's total energy will be generated in nuclear power plants. By 2000, the percentage is expected to increase to 67 percent and to 72 percent by 2020. Fossil fuel steam plants are expected to remain the major source of electric power to the year 1985 at which time they are expected to generate 50 percent of total Market Area energy requirements. By the year 2000, however, fossil fuel's share dips to 29 percent and to 26 percent by 2020. It is anticipated that the remainder of the energy requirements will be met by hydroelectric and combustion type plants and possibly other generating modes presently not available.

Shown on Figure 40 are the projected steam electric power plant sites for the year 2000. Table 39 gives the sizes and locations of these plants. Consideration was given only to steam-electric plants, both nuclear and fossil fuel, because of their demands for cooling water and consequent potential impacts on the aquatic environment and shoreline areas. These two means of generation are expected to produce about 96 percent of the electrical energy required in the Chesapeake Market Area in 2000. The locations of future facilities is fairly well known through 1985, but, for installations scheduled beyond 1985, there is a great deal of uncertainty regarding specific sites. The location of these plants was based on several criteria including the availability of ample water supply, proximity to load centers, and the need to keep transmission lines short. In addition, sites in Maryland were selected in accordance with criteria developed by the Maryland Power Plant Siting Program although these sites were not necessarily those chosen under the Siting Program.

Because of the degree of uncertainty attending site location in the long-range future, no attempt was made to predict where plants would be located beyond 2000.

COOLING WATER CONSIDERATIONS

Figure 41 illustrates the expected levels of water use and consumption by power plants for selected years. The information for the 1980-2000 period in Figure 41 is taken from Tables 13-10 and 13-11 of Appendix 13 and accounts for both new units added and old units removed throughout the period. For 2000 through 2020, water use rates are assumed to be the same as those for the year 2000 although technological improvements between 2000 and 2020 may reduce the water requirements shown in Figure 41. Water withdrawals are expected to decrease over the projection period so that by 2020 withdrawals will be 18 percent of the 1972 figure. Water consumption, however, is projected to increase by approximately nine times. This apparent discrepancy is due to two factors. First, once-through cooling systems, which have much higher withdrawal rates than other types of cooling systems, are prohibited on all plants scheduled to begin service on or after 1985. Second, it was assumed that cooling towers would be used for all projected capacity after 1985. Cooling towers

TABLE 39
STEAM-ELECTRIC PLANTS IN THE CHESAPEAKE BAY MARKET AREA, 2000

Plant	Fuel	Service-Area	Location		Capability
			City	State	
Chesapeake West					MW
Douglas Point	Nuclear	Potomac El Pr. Co.	Nanjemoy	MD	3400
Calvert Cliffs	Nuclear	Baltimore G&E Co.	Lusby	MD	3304
Bush River*	Nuclear	Baltimore G&E Co.	Bush River	MD	3000
Elms*	Nuclear	Potomac El Pr. Co.	St. Marys City	MD	3000
Lake Shore*	Nuclear	Baltimore G&E Co.	Millersville	MD	3000
Aquasco*	Nuclear	Potomac El Pr. Co.	Aquasco	MD	2700
Chalk Point	Fossil	Potomac El Pr. Co.	Brandywine	MD	1890
Morgantown	Fossil	Potomac El Pr. Co.	Newburg	MD	1801
Brandon Shores	Fossil	Baltimore G&E Co.	Foremans Corner	MD	1800
Wagner	Fossil	Baltimore G&E Co.	Arundel Village	MD	774
Benning	Fossil	Potomac El Pr. Co.	Benning	DC	580
					25249
Chesapeake East					
Summit	Nuclear	Delmarva P&L Co.	Summit Bridge	DE	3040
Conowingo*	Nuclear	Conowingo Pr. Co.	Conowingo	MD	3000
Thornton*	Nuclear	Delmarva P&L Ma.	Still Pond	MD	3000
Bethlehem*	Nuclear	Delmarva P&L Ma.	Bethlehem	MD	2700
Red Lion*	Fossil	Delmarva P&L Co.	Red Lion	DE	2000
Havre-de-Grace*	Fossil	Conowingo Pr. Co.	Havre-de-Grace	MD	1000
Vienna	Fossil	Delmarva P&L Ma.	Vienna	MD	962
Indian River	Fossil	Delmarva P&L Co.	Millsboro	DE	677
Edge Moor	Fossil	Delmarva P&L Co.	Edge Moor	DE	564
McKee Run	Fossil	Dover Municipal	Dover	DE	110
					17053
Chesapeake South					
Free Ferry*	Nuclear	Virginia E&P Co.	Barco	NC	3760
North Anna	Nuclear	Virginia E&P Co.	Minerva	VA	3760
Surry	Nuclear	Virginia E&P Co.	Surry	VA	3290
Chowan*	Nuclear	Virginia E&P Co.	Cofield	NC	2820
Ramirez*	Nuclear	Virginia E&P Co.	Mamie	NC	2820
Roanoke*	Nuclear	Virginia E&P Co.	Palmyra	NC	2820
Yorktown	Fossil	Virginia E&P Co.	Yorktown	VA	2660
Claremont*	Fossil	Virginia E&P Co.	Claremont	VA	2535
Possum Point	Fossil	Virginia E&P Co.	Dumfries	VA	2180
Smithfield*	Fossil	Virginia E&P Co.	Smithfield	VA	1690
Chesterfield	Fossil	Virginia E&P Co.	Chester	VA	1484
Portsmouth	Fossil	Virginia E&P Co.	Chesapeake	VA	1050
					30870
				Total	73172

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* Plant projected and sited by FPC; all others are existing or scheduled by the utilities.

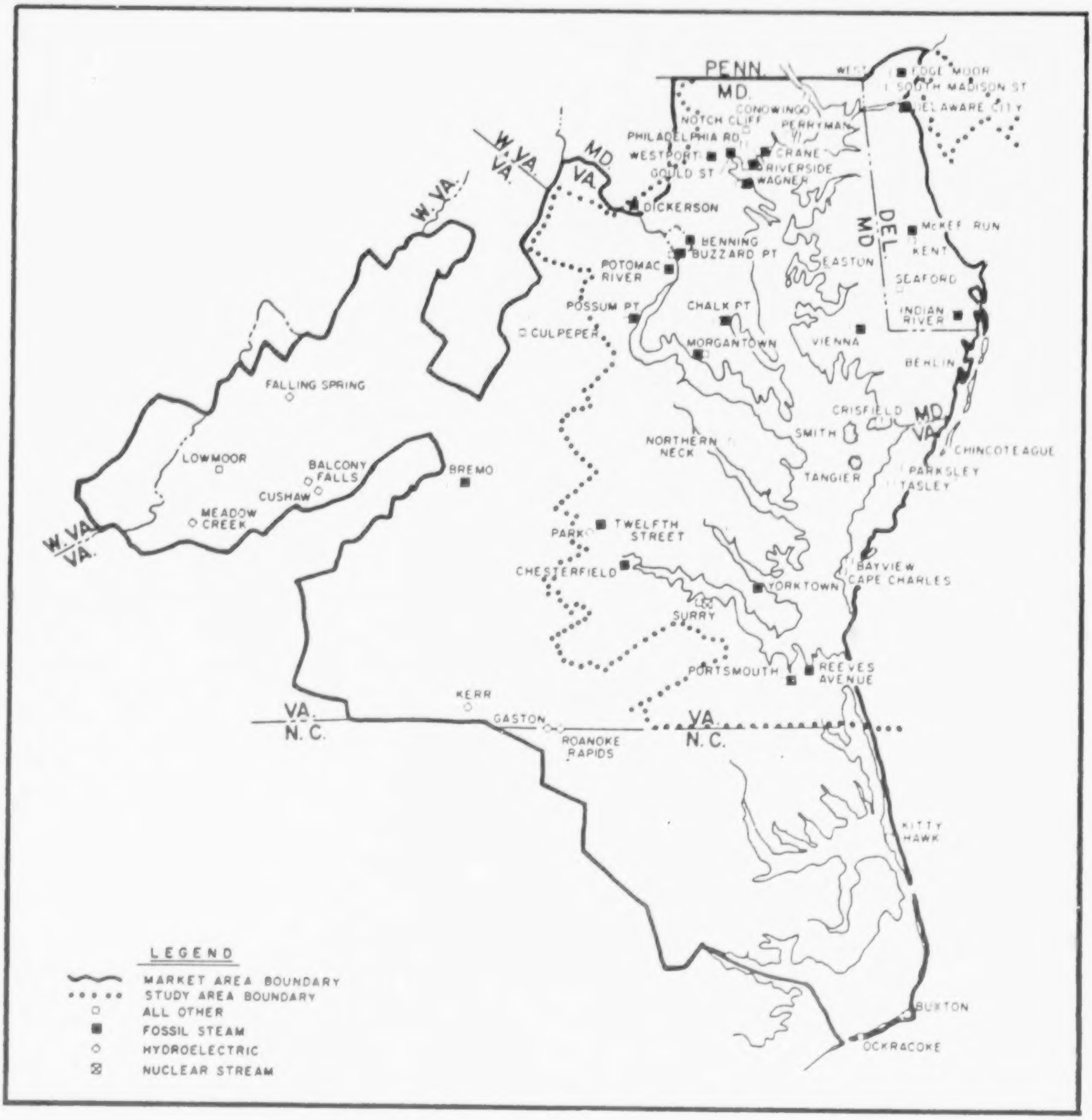


Figure 40: Chesapeake Bay Power Plant Location Map, 2000

have much higher consumption rates than once-through cooling systems.

LAND USE BY POWER FACILITIES

Estimates of electric utility land use in the Chesapeake Bay Study Area was restricted to that required for large steam electric plants and the related high-voltage transmission rights-of-way. No attempt was made to estimate land use requirements associated with subtransmission or distribution facilities.

Power plant land requirements vary with regard to plant type, size, location and fuel use.
Table 40 shows projected land requirements for power plants within the Chesapeake Bay Study Area, as defined in Figure 1. The magnitude of the quantity of land needed for future power plant sites is obvious when it is realized that the land area of Washington, D.C. is about 42,900 acres.

It is reasonable to assume that the land occupied by future transmission lines will also increase significantly, especially considering the fact that nuclear plants will have to be located further away from population centers for safety reasons. This is somewhat offset by the fact that transmission lines will probably have a higher capacity in the future.

SENSITIVITY ANALYSIS

The projections of future demands for water and land by power plants in the Bay Region in the preceding sections were based on the assumption of a "conservative" growth in the demand for electric power. As part of the power analysis, the sensitivity of

increase by approximately 30 percent in the year 2000 and about 95 percent in 2020. Under a "low" rate of growth assumption, which is a further dampening of the "conservative" growth trend, water and land requirements would decrease by approximately 20 percent in 2000 and about 30 percent in 2020. Water and land requirements under both the low and conservative growth assumptions were shown to be significantly lower than under the historical trend growth rate. Table 13-15 in Appendix 13 presents more detailed data on the results of this analysis.

The sensitivity analysis section of Appendix 13 also investigated the impact on water withdrawal and consumption in the year 2020 of varying the future fossil/nuclear plant mix and closed-cycle/once-through cooling system mix. The results for water withdrawal varied from a low of 1541 mgd with an all fossil fuel, all closed cycle system to a high of 4551 mgd with an all nuclear, all once-through system. Water consumption ranged from 452 mgd for all fossil fuel, once-through plants to 1,313 mgd for all nuclear, closed cycle plants. It is obvious from this analysis that any economic considerations or government regulations affecting the type of fuel or cooling system allowed in power plants can have significant impacts on power plant water requirements.

MEANS TO SATISFY ELECTRIC POWER NEEDS

The previous section presents one possible pattern of future load require- future demands for water and land to changes in the rate of growth was evaluated. Assuming a "high" rate of growth, which is an extension of historical trends, both water and land requirements would be expected to

ments and power supply based on reasonably expected economic and technological developments in the Chesapeake Bay Market Area. That portrayal is but one possibility of what may develop. By suitable extensions of utility technologies and applications of new philosophies of service modification (including public education programs designed to inform the public of the importance of energy conservation) the land and water use indicated might be altered dramatically. The sections which follow explore some of the areas where such modifications could appear.

WATER USE

Steam-electric plants offer a theoretical maximum thermal efficiency of some 55%, the remaining 45% of the

Figure 41: Projected Cooling Water in the Bay Market Area

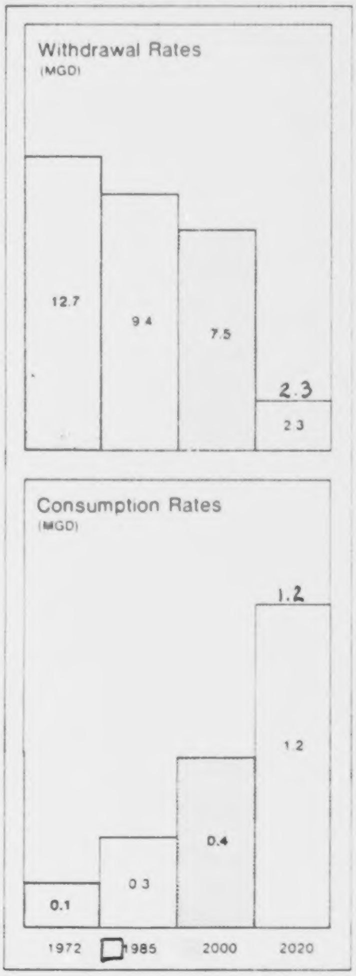


TABLE 40
PROJECTED LAND REQUIRED FOR STEAM ELECTRIC PLANTS
IN THE CHESAPEAKE BAY STUDY AREA (ACRES)

Sector	1985	2000	2020
Chesapeake East	3,300	8,400	21,800
Chesapeake West	6,700	16,500	41,300
Chesapeake South	6,100	9,200	26,700
TOTAL CHESAPEAKE BAY REGION	16,100	34,100	89,800

energy being rejected as heat. Actual efficiencies, including the mechanical and electrical losses, are about 40% for fossil plants and about 25% for nuclear plants.

The continued dependence on the thermal process to produce electricity will most probably result in the increasing use of the water from Chesapeake Bay and its estuarine and fresh-water tributaries for cooling purposes. Either the water is returned to the Bay in a heated condition for a once-through system or is lost at an increased rate to the atmosphere in a cooling tower system. Reduction of the water volumes so heated or consumed may possibly be accomplished in a number of ways – e.g., increasing steam-electric efficiencies, changing the generation mix, increasing waste heat utilization.

Steam-electric efficiencies may be increased through the development of better metals and other suitable materials in the heat transfer mechanism which could make possible a reduced production of reject heat corresponding to the same amount of electrical energy generated.

Hydroelectric and combustion plants could, to a limited degree, be substituted for steam-electric plants with the purpose of saving water; however the potential for additional hydro-electric generation is limited in the Study Area. In addition, combustion plants use an expensive grade of oil and are generally designed for limited operation. Such devices as magnetohydrodynamics, windmills, and solar cells use no water and may, conceivably, be brought into more common use early in the next century.

Reject heat is presently put to beneficial uses by providing steam for industrial and commercial purposes. Actually, such opportunities are now rare, but selected future industrial development might possibly be coordinated with the scheduling of generating plants to create an "industrial park" centered on the plant.

LAND USE

Virtually all existing electric power facilities are located above ground on sites dedicated for the single purpose of the particular facility. In the previous section, future electric power land use was approximated based on typical dimensions and samplings. The resultant order of demand for land in the Chesapeake Bay suggests a need for additional consideration of these requirements. The demand for land might be reduced by additional redevelopment of existing sites, more compact design of facilities, multiple use of future sites and rights-of-way, and underground construction.

LOAD MANAGEMENT

Historically, the demand for electric energy has been an outgrowth of the overall economic and social climate of the utility's territory. All demand was supplied in full without qualification other than economic return. Virtually all present day rate structures actually encourage energy use by lowering the unit price of energy as the consumption increases and by maintaining constant rates regardless of the time of day or season of year. In the interest of minimizing the water and land use necessary for electric power generation, demand manipulation and modification should also be considered. A possible means of restructuring rate schedules is the introduction of time dependency. The cost of producing electricity, and the ecological effects of such production varies throughout the day and year. If rates were made dependent on time, the price of the electricity could better convey to the consumer the costs associated with his demand for service and could encourage him to adjust his use toward the lower-priced periods of the day or year.

Much of the electrical energy purchased by the consumer is never transformed into useful work but is lost in the conversion process employed by the various household and industrial appliances and equipment. Part of the loss is due to the design of the appliance and part is due to the operation of the appliance by the consumer. By encouraging manufacturers and consumers to consider overall lifetime operating costs as well as the initial cost of the product, more efficient appliances could be marketed with a resultant reduction in demand.

NOXIOUS WEEDS

As previously mentioned in Chapter 2 of this Summary, the aquatic plants which inhabit the Chesapeake Bay Area waters are very important and serve as the primary producers or vital life line for other Bay species. Without the first link in the food chain provided by these plants, most forms of higher life within the Bay would suffer and the tremendous productivity of the Bay would decrease. However, as with any resource, an overabundance can also lead to problems. With some aquatic plants, excessive growths or heavy concentrations can cause conflicts and actually restrict the use of other resources. At this point, these plants become a hinderance and are termed "noxious weeds".

Noxious weed problems arise when the plants occur in such a place or to such an extent that they limit other beneficial water related uses such as navigation, recreation, fish and wildlife, water quality, and public health. In navigation channels, aquatic plants can and have grown sufficiently dense to block or impede boat traffic and present a navigation hazard. Recreation opportunities including swimming, boating and fishing have also been restricted as the result of excessive growths of several species. Fish and wildlife can be adversely affected when the plants occlude needed sunlight for food production, exhaust dissolved oxygen supplies, and "crowd out" plants which may be more desirable foods for waterfowl. Water quality problems that can be caused by excessive growths include low dissolved oxygen, reduction of the aesthetic value of water resources, and possible release of hydrogen sulfide gas from anaerobically decaying "blooms." Finally, public health can be endangered when the aquatic vegetation provides a favorable condition for the proliferation of mosquitoes which can transmit diseases such as malaria and encephalitis.

On a worldwide basis, noxious weed problems are of more concern in warmer latitudes than in the Chesapeake Bay Region. Central and South America, Africa, Asia, and the Southern United States all have more acute problems with the state of Florida alone spending almost $15 million annually on weed control programs. While certain aquatic plants have caused problems in the Bay Region in the past, today only an occasional isolated report of a noxious weed problem can be found. The problem species are still present in the Bay waters, but only as mere fragments of previous volumes, and none in sufficient numbers to require comprehensive control measures.

CURRENT STATUS

The plants which have caused the most widespread problems in Chesapeake Bay include Eurasian watermilfoil, water chestnut, and sea lettuce. While, as noted above, these species are presently not a problem in the Bay Region, a brief description of each is provided due to their potential for reemergence in the future. A more detailed discussion of the characteristics and history of each of these plants as well as other less prominent plants can be found in Appendix 14, "Noxious Weeds."

EURASIAN WATERMILFOIL

Eurasian watermilfoil is a submerged aquatic plant having an appearance as shown in Figure 42. Growing over a wide range of environmental conditions, the plant flourishes in water depths of up to 8 feet and in waters ranging from fresh to 15 ppt salinity. It roots easily in bottoms ranging from hard packed sand to muck, and under the right conditions grows rapidly to the water surface, sometimes forming a dense interwoven mat of material.

Known to be a native of Eurasia, the manner in which watermilfoil came to inhabit the waters of the United States is uncertain. It has been proposed, however, that either the plant came over in ships' ballasts which discharged into American waters, or that it came over initially in supplies of imported aquarium fish.

Watermilfoil problems were first documented in the Bay Area in the early 1930's and surfaced again in the late 1950's to early 1960's. The areas most affected by this weed were the Gunpowder and Middle River areas in the northern Bay Area and tributaries of the Potomac and Rappahannock Rivers in the lower Bay Area. From 1967 to the present time, however, Eurasian Watermilfoil has become increasingly scarce and its masses have been estimated at only one percent of its 1963 tonnage. In part, the reasons for the remarkable decline are two diseases which affect only the milfoil plants and the drought of the middle 1960's which caused salinities to increase above the plant's tolerance level.

WATER CHESTNUT

Like watermilfoil, the water chestnut is an import of Eurasian origin. The plant grows from seeds and produces as many as 10 to 15 rosettes or clumps of leaves which float on the water surface and can cluster up to 10 feet in diameter. A single rosette of the water chestnut is shown in Figure 43. The manner by which water chestnut distributes itself from one area to another is not fully understood, but the plant is known to tolerate no salinity and can grow in waters as deep as 15 feet. In areas of intense growth, the rosettes may become so crowded that the leaves are pushed upright out of the water forming a field of vegetation which makes boating, fishing, and other water related activities difficult if not impossible.

In the Chesapeake Bay Area, the water chestnut was first believed to have been planted as an ornament in goldfish ponds in Washington, D.C., before World War I. By 1923, the plant had spread to the Potomac River and ten years later almost 10,000 acres were infested near Alexandria, Virginia. More recently, the Gunpowder and Sassafras Rivers have had some water chestnut problems in 1955 and 1964, respectively. Today because of the many years of control efforts and expenditures for their removal, only yearly surveillance and hand pulling of the water chestnut is required to avoid problems.

SEA LETTUCE

Sea lettuce, a green alga with a worldwide distribution, grows mainly in estuaries and salt marshes of low current velocity, and salinity over 12 ppt. The general appearance of the plant is shown in Figure 44. Typically, the plants grow at scattered 2 or 3 foot intervals to depths of about 20 feet, but are most abundant on shallow sand flats. When washed up on beaches, the lettuce rots and produces various gases, the worst of which is hydrogen sulfide. This noxious gas can discolor lead paint, tarnish silverware, and in sufficient concentrations create a health hazard.

Sea lettuce problems have been documented for many years in the Bay Area, Long Island Sound, and at the many places along the back bays of the Atlantic Coast of New Jersey. In Maryland, the sea lettuce problem peaked in 1965 with most of the problems occurring in the Potomac River and its tributaries. Virginia's sea lettuce problems have centered basically around the Norfolk Area where local shoreline residents requested relief regularly during the 1960's. Fortunately, most problems arising as a result of sea lettuce growth are only of a temporary nature. The floating mats of lettuce typically remain for from two to six weeks and are usually washed away by currents, alleviating the problem.

HYDRILLA

A recent arrival to the Bay, hydrilla has appeared in the Potomac River (where it was planted by accident) and in several other areas in the Bay region. The Potomac location poses the biggest problem now, and authorities are examining mechanical and chemical controls. For advice they are turning to Florida, where hydrilla has long created a navigational nuisance in rivers and canals.

Unlike the Asian and European varieties, this American variety of hydrilla can reproduce sexually as well as by roots, buds, runners and broken fragments. At present, hydrilla seems to thrive in the fresher waters of the Potomac near the Woodrow Wilson Bridge, but it remains uncertain how far down the river it will migrate as it approaches the saltier waters of the Bay.

MEANS TO SATISFY FUTURE NEEDS

GENERAL

Although present water resource utilization is not hindered by the presence of aquatic plant growth in the Chesapeake Bay Area, the potential exists for problems to develop in the future. All plants require certain combinations of such growth factors as sunlight, salinity, temperature, and nutrients before growth and reproduction will occur. It is not known whether an improper balance of these growth factors or some other reason such as disease has caused the recent decline in many types of aquatic vegetation including noxious varieties in the Bay; but, new growth can be expected with the return of favorable conditions. If a resurgence of noxious plant growth creates conflicts with other uses of the Bay's resources, consideration will have to be given to control measures. This section provides a brief overview of the various categories of control measures that have been employed in the past and that have some potential for use in the Bay Region. More specific discussion of these measures can be found in Appendix 14, "Noxious Weeds."

CONTROL MEASURES

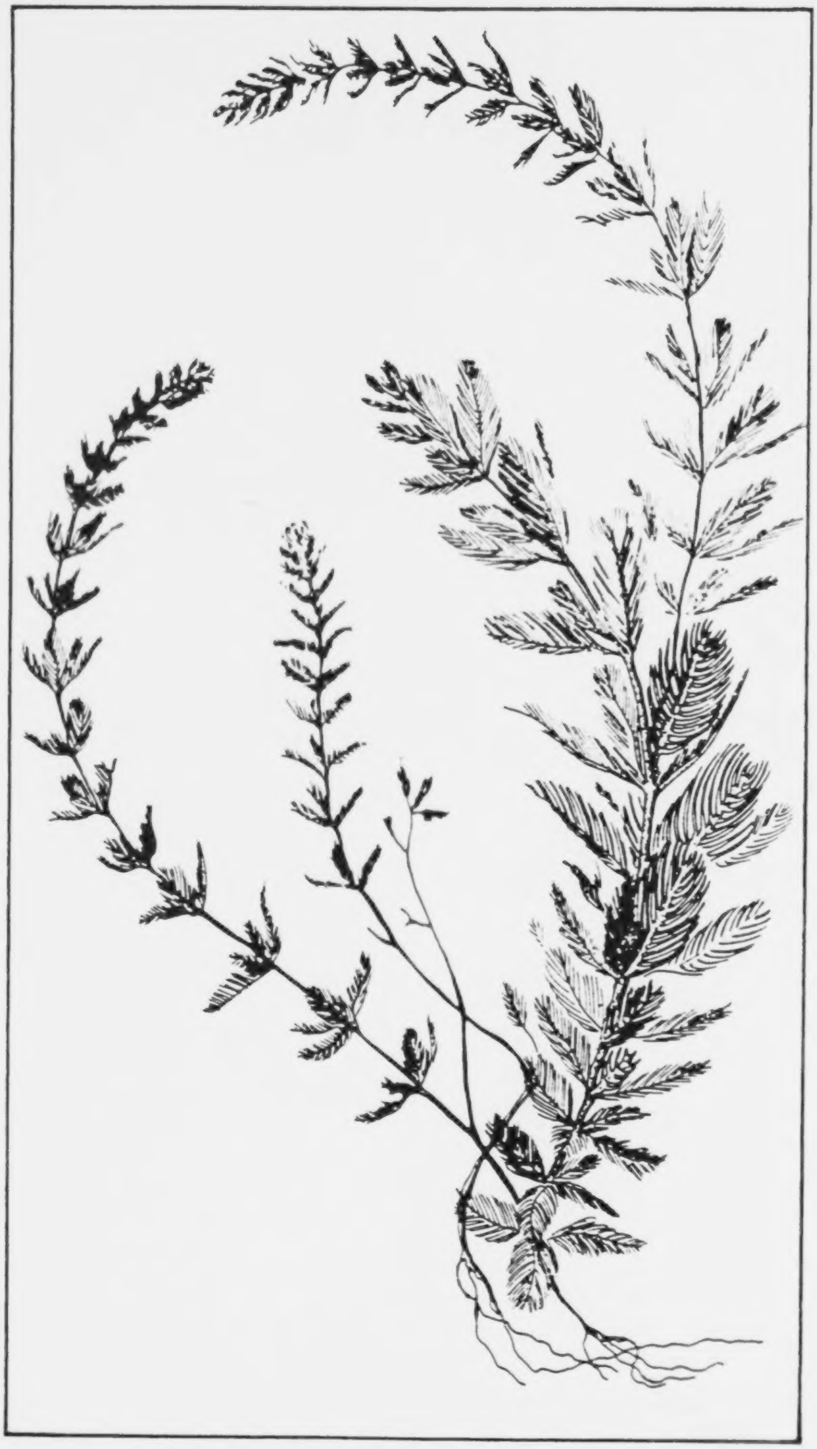
Since the emergence of aquatic plant problems in America at the end of the nineteenth century, many methods have been devised to control plant growths. Today, more sophisticated measures have been devised, researched, and put into practice for the eradication of noxious weed problems. These measures fall into three basic categories: chemical control, mechanical control, and biological control.

One of the most direct, time effective, and efficient means of controlling nuisance aquatic growths is through the use of chemicals. This involves the direct application of substances such as copper sulfate, 2,4-D, diquat, endothall, and silvex directly to the waters. However, the use of these chemicals must be carefully controlled because of their adverse side effects. In high concentrations, many of these herbicides are highly deleterious to aquatic organisms such as finfish and shellfish, and also may damage or eliminate desirable waterfowl food plants and other valuable vegetation. Another potential problem is the possible adverse effect on human beings who ingest water or food that is contaminated with these chemicals.

Mechanical aquatic weed control involves the use of various types of equipment to cut, uproot, collect, mash, and otherwise destroy the plants. In use for some time, the first mechanical control programs used a crusher which pulverized the plants and left the remains to sink and rot in the water. Newer types of equipment that have and are being investigated for possible field operations include spray equipment, wood chippers, devices for transporting personnel and equipment over difficult terrain, amphibious tractors, and a machine which floats on its own cushion of air at high speeds.

Biological control of noxious aquatic plants is perhaps the most ideal from a cost and permanence point of view. In the form of plant pathogens or insect or animal predator species, this type of control can become self-perpetuating at virtually no cost other than that needed to initiate the process. Insect or animal predators that are being investigated in aquatic control programs include the Agasicles beetle, the white amur (an herbivorous fish), and other animals such as snails, crayfish, thrips, moths, grasshoppers, aphids, and the manatee. Plant diseases, such as various forms of fungi, bacteria, and viruses are also being investigated for the control of the water hyacinth and the watermilfoil. Experimental efforts to utilize these biological methods with a minimum of adverse impacts have been successful in some areas of the United States in recent years, although a complete understanding of the complicated process involved is still somewhat lacking.

Figure 42: Eurasian Watermilfoil



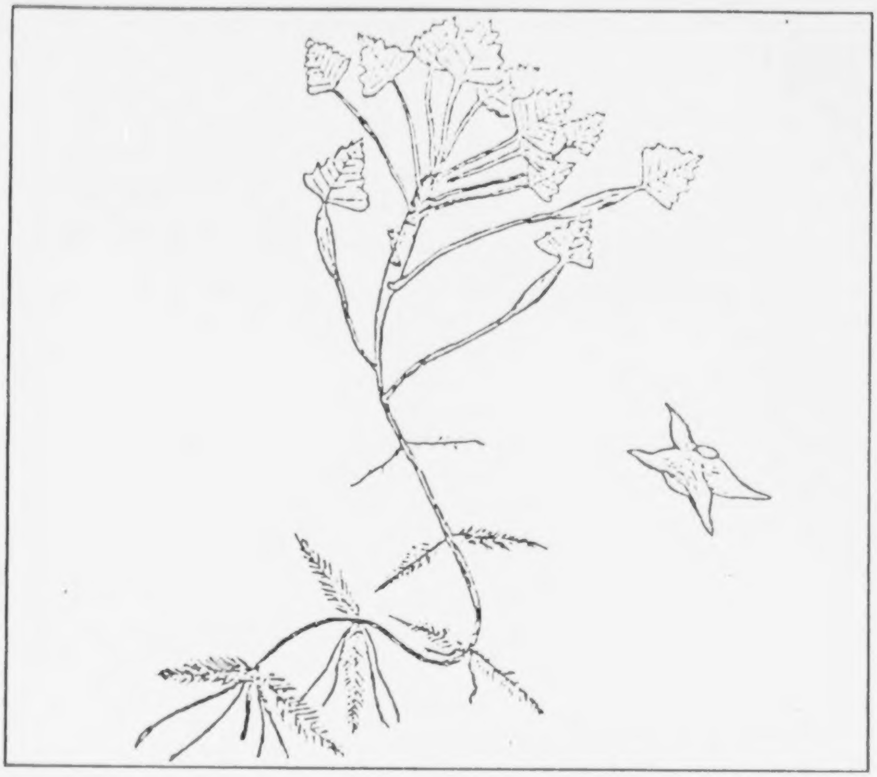
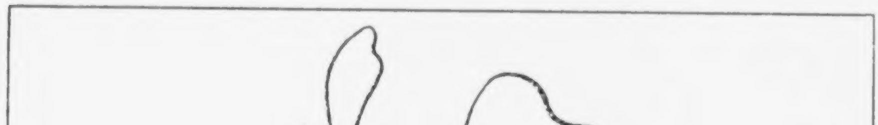


Figure 43: Water Chestnut

Figure 44: Sea Lettuce



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Epilogue

Since Captain John Smith first explored Chesapeake Bay in 1608, many changes have taken place—changes which have resulted in a thriving, diversified economy and one of the highest standards of living in the United States for the residents of the Chesapeake Bay Region. However, this rise in the standard of living has not been without sacrifices or trade-offs regarding the Bay's resources. Man has cut vast virgin forests, destroyed many thousands of acres of wetlands, used the Bay and its tributaries as receiving waters for municipal and industrial wastes, and added huge quantities of sediments to the Bay's waters.

Man's misuse of the Bay's resources was usually not intentionally malicious. It was simply a matter of people performing the acts of living, working and playing, that have been the genesis of most of the Bay's problems. Compounding the situation was a general lack of understanding of the complexities and interrelationships of the Bay's ecosystem and the finite capacity of the Bay to assimilate wastes.

In 1974, 366 years after Captain Smith's voyage up the Bay, there were 8.2 million people living in the Bay Region. Population in the Bay Region has more than doubled since 1940. These rapid growth rates have compounded the Bay-related problems by overloading the capacities of existing water supply, waste treatment, and recreational facilities.

During the next 50 years, population is projected to more than double once again so that by the year 2020 approximately 16.3 million people will reside in the Bay Region. As a result of these projected increases in population, as well as expected increases in per capita income and manufacturing output, significant additional demands will be placed on Chesapeake Bay's water and related land resources. For example, 31 of the 49 major central water supply systems in the Region are expected to have average water demands which will exceed presently developed supplies; water consumption by both industry and power plants is projected to increase by nearly nine times; boating and sailing activity is projected to increase by more than five times and swimming by nearly four and one-half times; total waterborne commerce on Chesapeake Bay is expected to approximately double; and nearly 20,000 acres of land within the 100-year tidal flood plain have been proposed for intensive development.

Although there is much room for honest debate over the magnitude of the projected levels of demands on the Bay's resources presented in this report, there is no debate about the assertion that there will be continued development by man in the Chesapeake Bay Region. With proper planning, tomorrow's development will be tempered by a growing awareness of the environmental costs of unregulated growth, and also by the knowledge that environmental enhancement and preservation have often significant economic costs which cannot be disregarded. Informed decisions will have to be made concerning future uses of the Bay's resources based on a thorough analysis of *all* the costs and benefits—economic, environmental, and social.

Essential inputs to such a planning effort are both study and research designed to provide a better understanding of the incredibly complex ecological, economic, and environmental "system" called the Chesapeake Bay Region. An important part of such research should be work which is oriented toward gaining more knowledge of the role of the Estuary's natural physical and chemical processes in the overall health of the ecosystem. Research is also needed to provide a better understanding of the biological component of the ecosystem such as predator-prey relationships and the biological reasons for species population fluctuations. Also of critical importance is a need for methodologies to better estimate the value of such non-market items as an acre of wetland, a day of birdwatching, an endangered species habitat, or the aesthetic appeal of a clean river or bay.

There are numerous studies and research projects underway at all levels of government and at private institutions which are addressing these types of problems. Unfortunately, research efforts are sometimes not coordinated and therefore much time and money is lost due to duplication of effort and/or lack of direction.

In addition to their involvement in research efforts, a large number of Federal, State, and local agencies, as well as several interstate commissions, are involved in different aspects of water resource management in the Region. Inconsistencies in the laws promulgated by these various levels of government, many of which have conflicting interests, often create problems in what is essentially a regional resource– Chesapeake Bay.

The Corps of Engineers *Chesapeake Bay Existing Conditions Report* was the first major study effort which addressed Chesapeake Bay from a regional perspective. Just as important, the report contained much of the basic data required to project the future demands on the Bay. The primary focus of this study, the *Chesapeake Bay Future Conditions Report*, is to present the projection of water resource needs to the year 2020 with the purpose of identifying the problems and conflicts which would result from the unrestrained growth in use of the Bay's resources. This report provides the basic information necessary to proceed into the next phase of the program which is the formulation and recommendation of solutions to priority problems.

The Chesapeake Bay Hydraulic Model at Matapeake, Maryland, will be a major planning tool during the next phase of the study. The nine acre model will provide a means of reproducing, to a manageable scale, some of the physical phenomena (e.g., currents, tides, salinities) that occur throughout this large and complex system. In addition, as an operational focal point it will promote more effective liaison among the agencies working in the Bay Region by helping to reduce duplication of research and by leading to the accelerated dissemination of knowledge among interested parties. The model will also be extremely valuable as an educational tool for the public in the magnitude and complexity of the problems and conflicts facing Chesapeake Bay. Construction of the Chesapeake Bay Model was completed in May 1976. Verfication, or "fine-tuning" of the model is currently underway and is scheduled for completion in 1977.

Based on the findings of the *Future Conditions Report*, the capabilities and limitations of the Hydraulic Model, and input from the Study's public involvement program, exsting and potential management problems will be identified and prioritized. In prioritizing these problems, emphasis will be placed on (1) selecting problems for study that are considered to be high priority and that have Bay-wide significance; (2) maximizing the use of the Chesapeake Bay Hydraulic Model; and (3) avoiding any duplication of work being conducted under other existing or proposed programs. Major problem areas under consideration for further study during the next phase of the Study include the effects on the Bay and its people of extreme freshwater inflow conditions, navigation channel modifications, increases in power plant thermal effluents, tidal flooding, and wastewater dispersion.

The findings of the *Future Conditions Report* and the Chesapeake Bay Hydraulic Model will add tremendously to the growing body of knowledge of the Chesapeake Bay system. The system is immensely complex, however, and future increases in many types of demands will be great in magnitude and rapid in occurrence. We cannot hope to completely understand the workings of the entire system. We can, however, develop enough knowledge to identify future activites by man which would result in significant adverse or beneficial impacts on the integrity of Chesapeake Bay and the welfare of the people of the Region and Nation. The goal, not only of the Corps of Engineers, but also of all parties interested in the future of Chesapeake Bay, is a well-coordinated water-land management plan which will guide man in utilizing the resources of Chesapeake Bay to provide the greatest benefits to the greatest number of people.

CHESAPEAKE BAY DATA BANK GLOSSARY

Aquifer—A sedimentary layer of earth or porous rock that contains water. Like a surface stream, water in an aquifer flows underground from the source to discharge points — either wells, swamps, springs, or lakes.

Bay Region—The geographical area which includes those counties which are located on the Chesapeake Bay or one of its tidal tributaries. (See *tributary*)

Bacteriological Indicators—Coliform bacteria are found in the feces (solid wastes) of humans and animals. Coliform bacteria, although harmless to humans, are found with pathogenic bacteria in domestic waste products. Pathogenic bacteria cause diseases. Bacterial counts are made with the assumption that if coliform bacteria are present, pathogenic bacteria are also likely to be present. (See *coliform*)

Biochemical Oxygen Demand (BOD)—A measure of oxygen depleting power of the organics in a waste water discharge.

Biome—A natural community of interacting plants and animals with its composition largely controlled by climatic conditions.

Biomass—The total mass or weight of living material in a unit of area.

Bloom—A sudden development of large numbers of organisms, such as algae, in bodies of water.

Brackish Water—A mixture of salt water from the ocean and freshwater from the land with a salinity greater than one part per thousand (ppt).

Coliform—A type of bacteria found in the intestines of animals and humans.

Channelization—Changing the course and shape of a stream bed to permit more efficient stream flow.

Consumer—Any living thing that is unable to manufacture its own food from nonliving substances and which depends instead on the energy stored in other living things which it eats for its food supply.

Consumption (Water)—The amount of water lost between the points of intake and discharge through incorporation into products, evaporation, etc.

Deadweight Tonnage (DWT)—The weight in tons (2000 lb/ton) of cargo, supplies, fuel, passengers and crew when a ship is loaded to the maximum.

Detritus—Minute particles of decaying remains of dead plants, animals, and bacteria.

Dissolved Oxygen (DO)—The amount of oxygen dissolved in water. Adequate DO is necessary for the survival of fish and other aquatic organisms. DO is measured in units of parts per million (ppm) dissolved oxygen found in the water.

Dissolved Solids—A measure of the total amount of organic and inorganic material which has been dissolved in water. Sulfates, carbonates, phosphates, nitrates, and chlorides are among the most common dissolved solids.

Draft—The distance from the water level to the lowest point of the vessel which is under water.

Ecology—A branch of science concerned with the interrelationship of organisms to one another and to the environment.

Ecosystem—System of exchanges of materials and energy between living things and their physical environment. The living or biotic community and the nonliving environment function together as a system.

Endangered Species—Those species of animals and plants which are so few in numbers as to be in danger of extinction throughout their natural habitat.

Estuary—A semienclosed coastal body of water which has a free connection with the open sea. Estuaries are strongly affected by tidal action and the mixing of seawater with freshwater from land drainage. Examples are: mouths of rivers, coastal bays, tidal marshes, and bodies of water behind barrier beaches.

Eutrophication—The process by which a lake becomes rich in dissolved nutrients and deficient in oxygen. Eutrophication occurs either as a natural stage in lake maturation or is artificially induced by human activities, principally by the addition of fertilizers and organic wastes to the body of water.

Evapotranspiration—A combined loss of water from a given area by evaporation from surface water and from the transpiration of plants.

Fall Line—The geological boundary between softer sedimentary rocks and harder crystalline rocks. Usually, there is a waterfall as a river crosses the fall line because the sedimentary rocks wear away more easily than the crystalline rocks.

Food Web—A system of interlocking food chains in which energy and materials are passed through a series of plant-eating and meat-eating consumers.

Groundwater—Water found underground in porous rock or soil layers. (See *aquifers*)

Isohaline Lines—Lines on a map showing the varying degrees of salinity that exist within estuary waters. These lines slant upwards to the right due to the rotation of the earth.

Habitat—The place where a plant or animal species naturally lives and grows, its immediate surroundings.

Heavy Metals—Elements such as mercury, lead, zinc, chromium, cadmium, and arsenic which are important because of their poisonous effects in low concentrations to plants and animals. A problem with heavy metals is that many fish and shellfish concentrate these materials in their tissues, affecting the natural food chain and presenting a consumption hazard to man.

Hydroelectric Power—Electricity generated by the conversion of falling water into electrical energy.

Hydrology—A branch of science dealing with properties, distribution, and circulation of water.

Marsh—A wetland dominated by herbaceous or nonwoody plants, often developing in shallow ponds or depressions, river margins, tidal areas, and estuaries. Marshes may contain either salt or fresh water. Vegetation is dominated by grasses and sedges.

Maximum Sustainable Yield—The greatest harvest which can be taken from a population without affecting subsequent harvests.

Non-Point Sources—Those sources from which materials reach a watercourse from runoff over a large area (e.g., pesticides from fields), not from a particular location, as in point source (e.g., particulate matter from smokestacks).

Nutrient—A chemical element, organic compound, or inorganic compound used in the growth of living organisms.

Parent Material—The unweathered rock or organic matter from which soil is originated.

pH—The measure of hydrogen ion concentration. pH reflects either acidic or alkaline conditions. Neutrality is represented by a pH of 7. Alkaline (basic) conditions above 8.5 can decrease reproductive capabilities in many aquatic species. Acidic water, pH less than 6, can harm and even kill many forms of aquatic life.

Phytoplankton—Microscopic aquatic plants.

Pollutant—A substance, medium, or agent which causes physical impurity. Any gas, liquid, or solid whose nature contaminates the water, air, or ground to a level of quality which is less desirable.

Point Sources—Those sources in which material is discharged from a specific point (effluent from a wastewater treatment plant, effluent from a factory, warm water from a power plant are some examples.)

Producers—Primarily green plants. These are the basic link in any food web. By a means of photosynthesis, plants manufacture the food on which all other living things ultimately depend.

Salinity—Concentration of salt in water usually measured in parts per thousand (ppt).

Salinity Currents—Vertical movements in the estuarine waters caused by the density of the salts mixing with the less dense fresh water.

Sewage—Waste materials carried in sewers and drains. Refuse in water.

Siltation—The formation of deposits of fine particles of clay, sand, or other particles that have been carried by moving water.

Soil—Upper layer of earth consisting of disintegrated rock with a mixture of organic matter, water, and air in which living organisms may be found.

Suspended Solids—Those solids which remain suspended in water and cannot pass through the holes in a standardized filter one millionth of an inch in diameter.

Tidal Currents—Horizontal movements in ocean and estuarine waters caused by changes in the elevation of the surface through tidal changes.

Tidal Flooding—The flooding of land by tides higher than those usually caused by hurricanes or "northeasters".

Tributary—A stream of water that flows into a larger body of water; for example, the Potomac River is a tributary of the Chesapeake Bay. Any river that flows into the Bay is a tributary of the Bay. Such rivers also have many smaller tributary streams of water flowing into them.

Turbidity—A state of having disturbed sediment, of being opaque, cloudy, or muddy, with matter in suspension.

Wetlands—Any area characterized by high soil moisture and often high biological productivity, where the water table is at or near the surface for most of the year.

Zooplankton—Microscopic animals in water.